SPC BENCHMARK 1™
FULL DISCLOSURE REPORT

FUJITSU LIMITED
FUJITSU STORAGE SYSTEMS ETERNUS DX80

SPC-1 V1.11

Submitted for Review: September 14, 2009
Submission Identifier: A00082

First Edition – September 2009

Trademarks

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AUDIT CERTIFICATION

C.A. (Sandy) Wilson
Fujitsu Limited
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P.O. Box 3470
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September 11, 2009

The SPC Benchmark 1™ results listed below for the Fujitsu Storage Systems ETERNUS DX80 were produced in compliance with the SPC Benchmark 1™ 1.11 Remote Audit requirements.

SPC Benchmark 1™ 1.11 Results	
Tested Storage Configuration (TSC) Name: Fujitsu Storage Systems ETERNUS DX80	
Metric	**Reported Result**
SPC-1 IOPS™	19,492.86
SPC-1 Price-Performance	$3.45/SPC-1 IOPS™
Total ASU Capacity	5,355.400 GB
Data Protection Level	Protected *(Mirroring)*
Total TSC Price (including three-year maintenance)	$67,296.40

The following SPC Benchmark 1™ Remote Audit requirements were reviewed and found compliant with 1.11 of the SPC Benchmark 1™ specification:

- A Letter of Good Faith, signed by a senior executive.
- The following Data Repository storage items, based on information supplied by Fujitsu Limited:
  - ✓ Physical Storage Capacity and requirements.
  - ✓ Configured Storage Capacity and requirements.
  - ✓ Addressable Storage Capacity and requirements.
  - ✓ Capacity of each Logical Volume and requirements.
  - ✓ Capacity of each Application Storage Unit (ASU) and requirements.
- An appropriate diagram of the Benchmark Configuration (BC)/Tested Storage Configuration (TSC).
- Listings and commands to configure the Benchmark Configuration/Tested Storage Configuration, including customer tunable parameters that were changed from default values.

Storage Performance Council
643 Bair Island Road, Suite 103
Redwood City, CA 94062
AuditService@storageperformance.org
650.556.9384

AUDIT CERTIFICATION *(CONT.)*

- SPC-1 Workload Generator commands and parameters used for the audited SPC Test Runs.
- The following Host System requirements, based on information supplied by Fujitsu Limited:
  - ✓ The type of Host System including the number of processors and main memory.
  - ✓ The presence and version number of the SPC-1 Workload Generator on each Host System.
  - ✓ The TSC boundary within each Host System.
- The Test Results Files and resultant Summary Results Files received from Fujitsu Limited for each of following were authentic, accurate, and compliant with all of the requirements and constraints of Clauses 4 and 5 of the SPC-1 Benchmark Specification:
  - ✓ Data Persistence Test
  - ✓ Sustainability Test Phase
  - ✓ IOPS Test Phase
  - ✓ Response Time Ramp Test Phase
  - ✓ Repeatability Test
- The differences between the Tested Storage Configuration (TSC) used for the benchmark and Priced Storage Configuration were documented and, if applied to the TSC, would not have an impact on the reported SPC-1 performance.
- The submitted pricing information met all of the requirements and constraints of Clause 8 of the SPC-1 Benchmark Specification.
- The Full Disclosure Report (FDR) met all of the requirements in Clause 9 of the SPC-1 Benchmark Specification.
- This successfully audited SPC measurement is not subject to an SPC Confidential Review.

Audit Notes:

There were no audit notes or exceptions.

Respectfully,

Walter E. Baker
SPC Auditor

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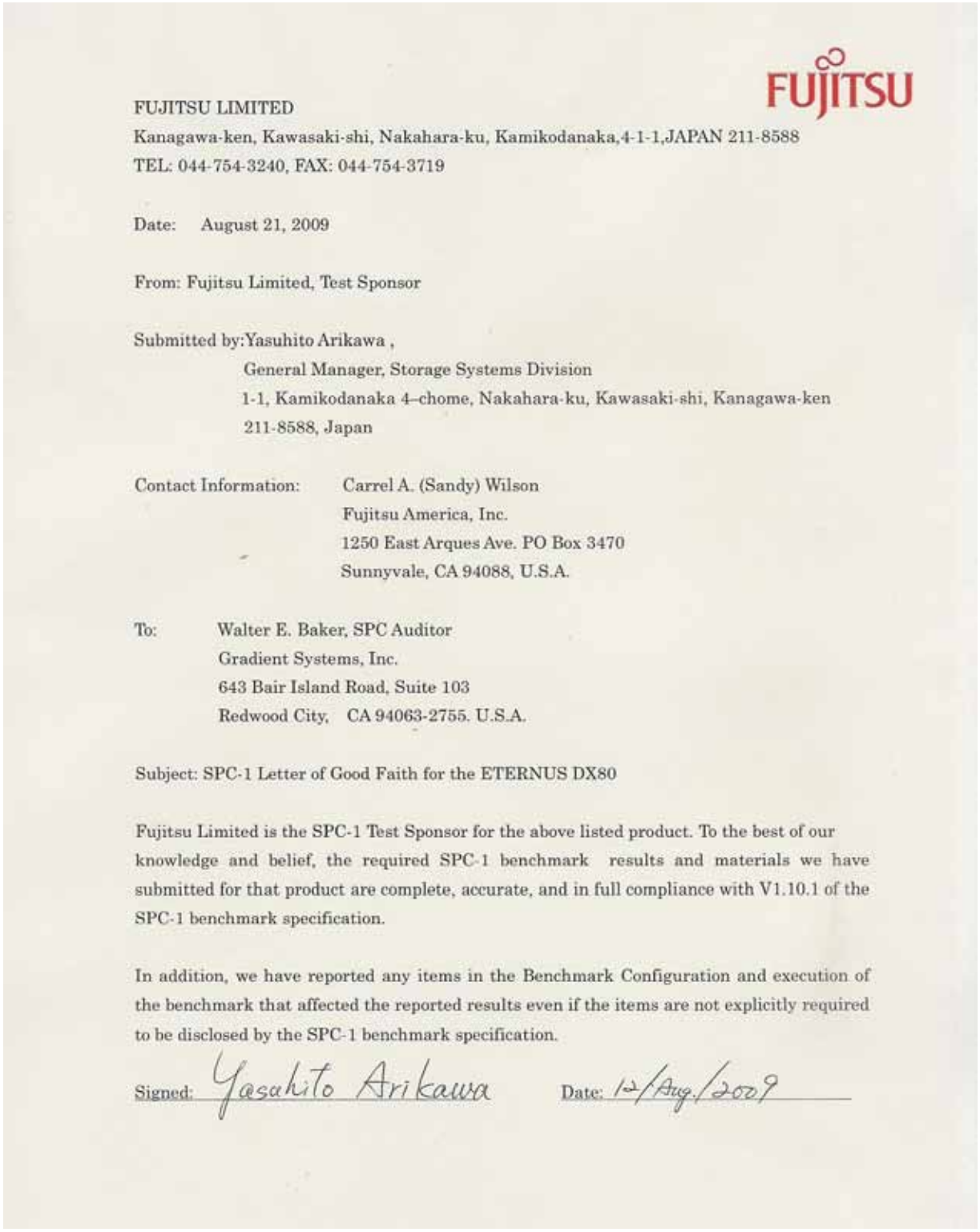
LETTER OF GOOD FAITH



FUJITSU

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Kanagawa-ken, Kawasaki-shi, Nakahara-ku, Kamikodanaka,4-1-1,JAPAN 211-8588
TEL: 044-754-3240, FAX: 044-754-3719

Date: August 21, 2009

From: Fujitsu Limited, Test Sponsor

Submitted by:Yasuhito Arikawa ,
General Manager, Storage Systems Division
1-1, Kamikodanaka 4–chome, Nakahara-ku, Kawasaki-shi, Kanagawa-ken
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Contact Information: Carrel A. (Sandy) Wilson
Fujitsu America, Inc.
1250 East Arques Ave. PO Box 3470
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To: Walter E. Baker, SPC Auditor
Gradient Systems, Inc.
643 Bair Island Road, Suite 103
Redwood City, CA 94063-2755. U.S.A.

Subject: SPC-1 Letter of Good Faith for the ETERNUS DX80

Fujitsu Limited is the SPC-1 Test Sponsor for the above listed product. To the best of our knowledge and belief, the required SPC-1 benchmark results and materials we have submitted for that product are complete, accurate, and in full compliance with V1.10.1 of the SPC-1 benchmark specification.

In addition, we have reported any items in the Benchmark Configuration and execution of the benchmark that affected the reported results even if the items are not explicitly required to be disclosed by the SPC-1 benchmark specification.

Signed: Yasuhito Arikawa Date: 12/Aug./2009

EXECUTIVE SUMMARY

Test Sponsor and Contact Information

Test Sponsor and Contact Information	
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Test Sponsor Alternate Contact	Fujitsu Limited – http://www.fujitsu.com/services/computing/storage/ Yasuhita Arikawa y.arikawa@jp.fumitsu.com 1-1 Kamikodanaka 4-chrome, Nakahara-ku, Kawasaki-shi, Kanagawa-ken 211-8588, Japan Phone: (044) 754-3632 FAX: (044) 754-3719
Auditor	Storage Performance Council – http://www.storageperformance.org Walter E. Baker – AuditService@StoragePerformance.org 643 Bair Island Road, Suite 103 Redwood City, CA 94063 Phone: (650) 556-9384 FAX: (650) 556-9385

Revision Information and Key Dates

Revision Information and Key Dates	
SPC-1 Specification revision number	V1.11
SPC-1 Workload Generator revision number	V2.1.0
Date Results were first used publicly	September 14, 2009
Date the FDR was submitted to the SPC	September 14, 2009
Date the priced storage configuration is available for shipment to customers	currently available
Date the TSC completed audit certification	September 11, 2009

Tested Storage Product (TSP) Description

The Fujitsu ETERNUS DX80 is a flexible, highly reliable storage array, equipped with redundant components to provide uncompromised availability to the SMB market requirements. A mixture of 300GB and 450GB 15krpm SAS drives, as well as 750GB and 1TB Nearline SAS drives may be used, up to a maximum of 120 drives. The drives may be arranged in a variety of RAID groups, including RAID1, RAID1+0(10), RAID5, RAID5+0(50), and RAID6. The product is offered with Fibre Channel host connection, with 4 channels (2 channels per controller). SMI-S Version 1.2 is supported by the DX80 array. In addition, a number of different snapshot and replication facilities, disk data encryption, MAID capabilities, and power consumption monitoring features are available

Summary of Results

SPC-1 Results	
Tested Storage Configuration (TSC) Name: Fujitsu Storage Systems ETERNUS DX80	
Metric	**Reported Result**
SPC-1 IOPS™	19,492.86
SPC-1 Price-Performance	$3.45/SPC-1 IOPS™
Total ASU Capacity	5,355.400 GB
Data Protection Level	Protected *(Mirroring)*
Total TSC Price (including three-year maintenance)	$67,296.40

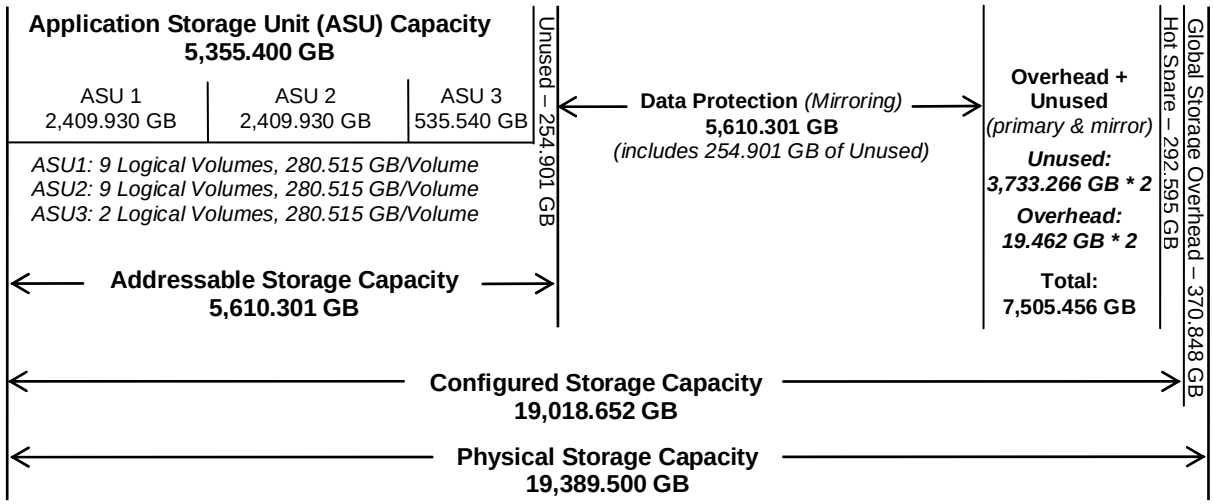
SPC-1 IOPS™ represents the maximum I/O Request Throughput at the 100% load point.

Total ASU (Application Storage Unit) **Capacity** represents the total storage capacity read and written in the course of executing the SPC-1 benchmark.

A **Data Protection Level** of **Protected** using ***Mirroring*** configures two or more identical copies of user data.

Storage Capacities, Relationships, and Utilization

The following diagram and table document the various storage capacities, used in this benchmark, and their relationships, as well as the storage utilization values required to be reported.



SPC-1 Storage Capacity Utilization	
Application Utilization	27.62%
Protected Application Utilization	55.24%
Unused Storage Ratio	41.14%

Application Utilization: Total ASU Capacity *(5,355.400 GB)* divided by Physical Storage Capacity *(19,389.500 GB)*

Protected Application Utilization: (Total ASU Capacity *(5,355.400 GB)* plus total Data Protection Capacity *(5,610.301GB)* minus unused Data Protection Capacity *(254.901 GB)*) divided by Physical Storage Capacity *(19,389.500 GB)*

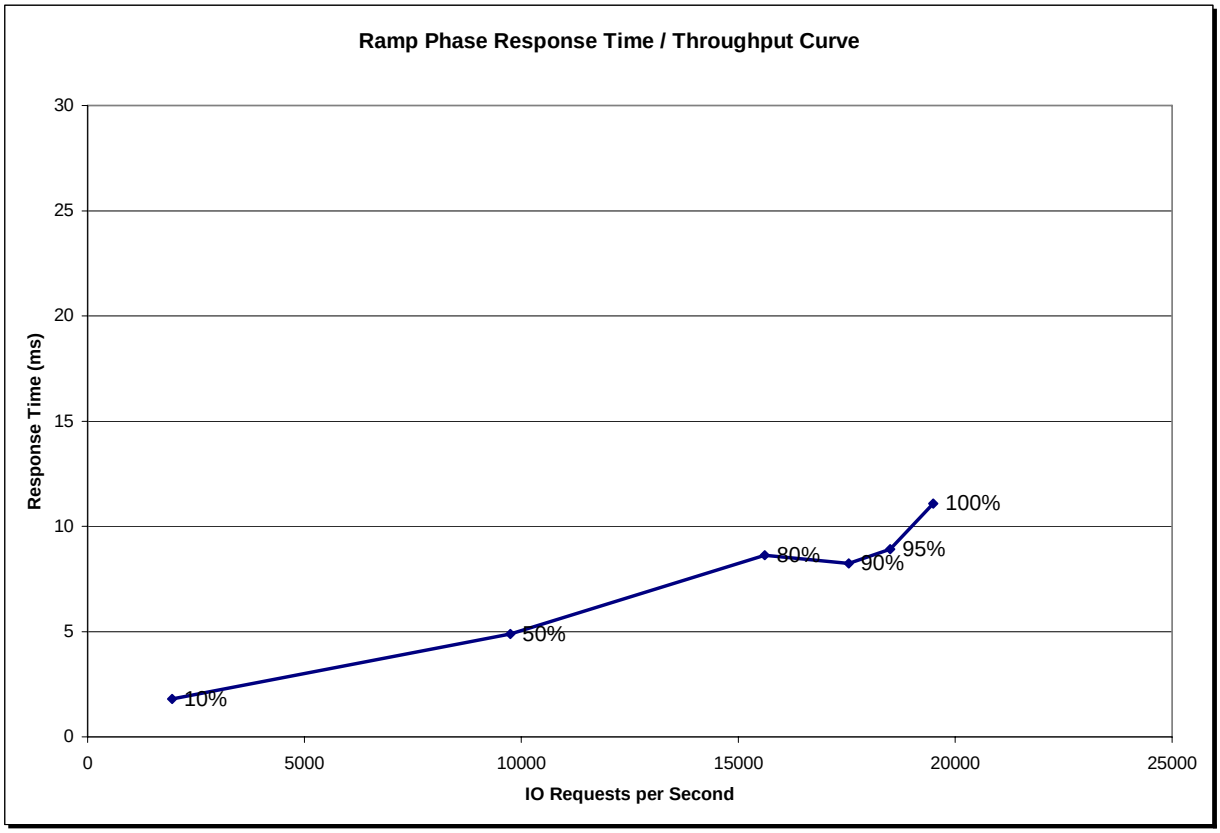
Unused Storage Ratio: Total Unused Capacity *(7,976.334 GB)* divided by Physical Storage Capacity *(19,389.500 GB)* and may not exceed 45%.

Detailed information for the various storage capacities and utilizations is available on pages 19-20 in the Full Disclosure Report.

Response Time – Throughput Curve

The Response Time-Throughput Curve illustrates the Average Response Time (milliseconds) and I/O Request Throughput at 100%, 95%, 90%, 80%, 50%, and 10% of the workload level used to generate the SPC-1 IOPS™ metric.

The Average Response Time measured at any of the above load points cannot exceed 30 milliseconds or the benchmark measurement is invalid.



Response Time – Throughput Data

	10% Load	50% Load	80% Load	90% Load	95% Load	100% Load
I/O Request Throughput	1,946.07	9,748.06	15,605.72	17,549.20	18,501.14	19,492.86
Average Response Time (ms):						
All ASUs	1.79	4.90	8.64	8.25	8.91	11.07
ASU-1	2.34	5.72	9.57	9.22	9.90	12.08
ASU-2	1.71	4.95	9.24	9.18	10.06	12.54
ASU-3	0.68	3.12	6.40	5.77	6.30	8.30
Reads	3.52	7.68	12.36	12.40	13.37	15.95
Writes	0.67	3.08	6.22	5.54	6.01	7.90

Priced Storage Configuration Pricing

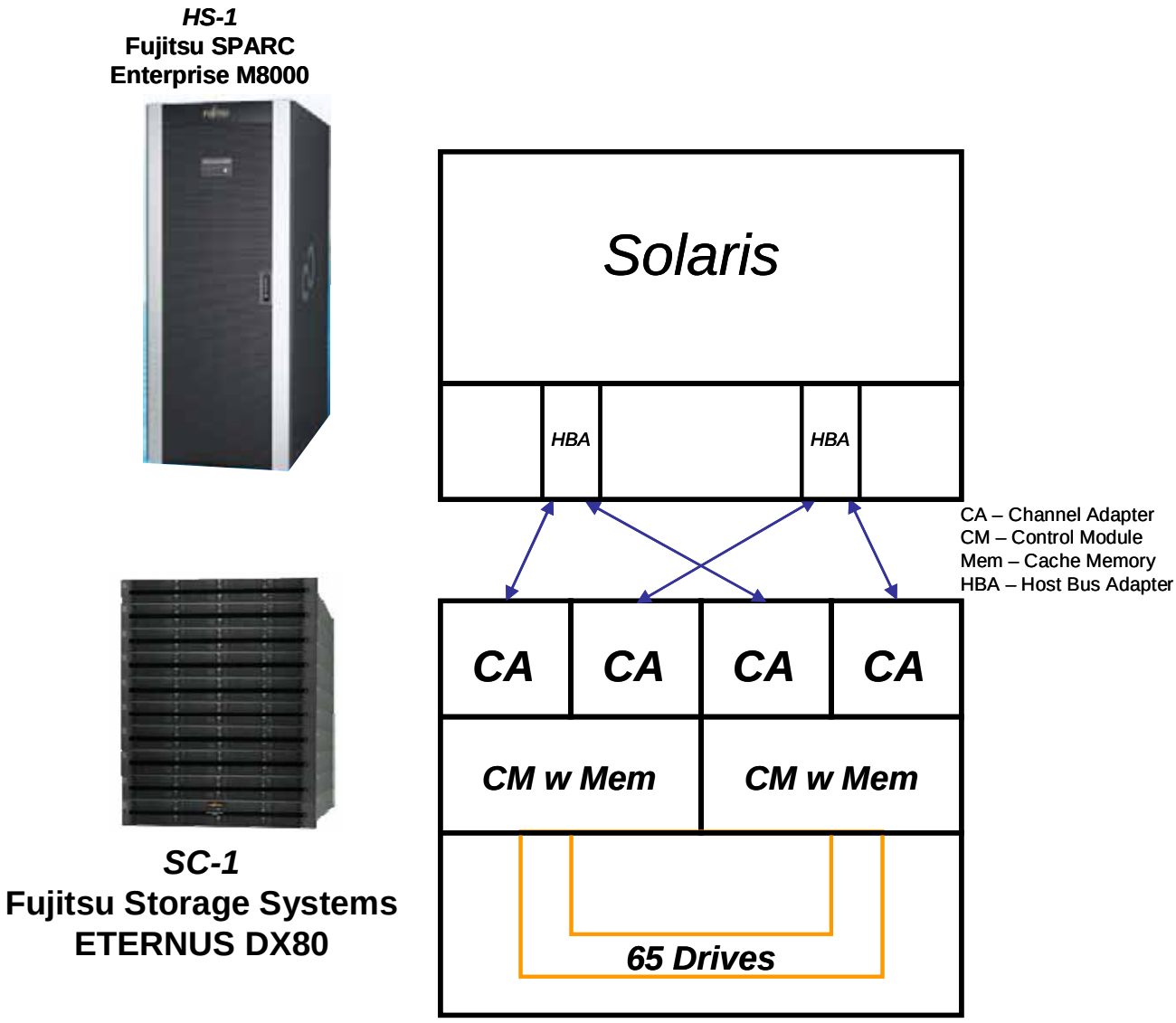
Product ID	Product name	Qty	Unit LP	Extended LP	Discount %	Discounted Price
ET08E22AU	ETERNUS DX80 Base unit (FC 8Gbps 4 ports)	1	$12,750.00	$12,750.00	30%	$8,925.00
ETLDE2AU	Additional drive enclosure for 2CM DX80	5	$3,000.00	$15,000.00	30%	$10,500.00
ETLSA3HAU	300GB/15Krpm(SAS) disk drive (single)	65	$740.00	$48,100.00	30%	$33,670.00
ETLAC2U2U	Power distribution unit (2U)	2	$1,410.00	$2,820.00	30%	$1,974.00
LPE11002-M4	Emulex 4Gb PCIe 2.5GGhz Dual Channel Fibre Channel HBA	2	$2,565.00	$5,130.00	40%	$3,078.00
ETDX-EPLUPLT-BASE	ETDX2000, 1 Month; 24 x 7, 4-hour On-Site Resp.(Sev-1), Uplift Maintenance for Base Unit	36	$91.00	$3,276.00	35%	$2,129.40
ETDX-EPLUPLT-DE	ETDX2000, 1 Month; 24 x 7, 4-hour On-Site Resp.(Sev-1), Uplift Maintenance for DE	180	$60.00	$10,800.00	35%	$7,020.00
				Total		$67,296.40

Differences between the Tested Storage Configuration (TSC) and Priced Storage Configuration

There were no differences between the TSC and the Priced Storage Configuration.

Benchmark Configuration (BC)/Tested Storage Configuration (TSC) Priced Storage Configuration Diagram

The TSC/Priced Storage Configuration consists of the Fujitsu Storage Systems ETERNUS DX80 plus the HBAs and excludes the Fujitsu SPARC Enterprise M8000 Host System.



Benchmark Configuration/Tested Storage Configuration
Priced Storage Configuration Components

Host System:	Tested Storage Configuration (TSC) / Priced Storage Configuration:
HS-1: Fujitsu SPARC Enterprise M8000 16 – 2.4 GHz SPARC64 VI chips each with: 128 KB L1 instruction cache, 128 KB L1 data cache, 6 MB L2 cache	2 –LPE11002-M4 FC HBAs *(2 – 4 Gbit ports/ HBA)* *(rebranded Emulex LP12000)*
512 GB main memory	**SC-1: Fujitsu Storage Systems ETERNUS DX80** 2 – Controller Modules, each with: 2 GB cache *(4 GB total)* 2 – Channel Adapter modules, each with 1 – Fibre Channel port *(4 ports total, 4 ports used)* 2 – SAS Expander Drive interfaces
Solaris 10	
Solaris Volume Manager	
PCIe	
WG	
	4 – Front side Fibre Channels *(set to 4 Gbit each)* 2 – Back side SAS channels
	6 – Drive Enclosure Modules, each with: dual SAS interfaces, 12 – Hot Swap drive slots
	65 – 300 GB 15K RPM disk drives *(64 drives in 32 RAID Groups and 1 Hot Spare)*
	ETERNUS Administrator

In each of the following sections of this document, the appropriate Full Disclosure Report requirement, from the SPC-1 benchmark specification, is stated in italics followed by the information to fulfill the stated requirement.

CONFIGURATION INFORMATION

Benchmark Configuration (BC)/Tested Storage Configuration (TSC) Diagram

Clause 9.4.3.4.1

A one page Benchmark Configuration (BC)/Tested Storage Configuration (TSC) diagram shall be included in the FDR…

The Benchmark Configuration (BC)/Tested Storage Configuration (TSC) is illustrated on page 15 *(Benchmark Configuration/Tested Storage Configuration/Priced Storage Configuration Diagram).*

Storage Network Configuration

Clause 9. 4.3.4.1

…

5. *If the TSC contains network storage, the diagram will include the network configuration. If a single diagram is not sufficient to illustrate both the Benchmark Configuration and network configuration in sufficient detail, the Benchmark Configuration diagram will include a high-level network illustration as shown in Figure 9-8. In that case, a separate, detailed network configuration diagram will also be included as described in Clause 9.4.3.4.2.*

Clause 9.4.3.4.2

If a storage network was configured as a part of the Tested Storage Configuration and the Benchmark Configuration diagram described in Clause 9.4.3.4.1 contains a high-level illustration of the network configuration, the Executive Summary will contain a one page topology diagram of the storage network as illustrated in Figure 9-9.

The TSC did not utilize network storage.

Host System and Tested Storage Configuration (TSC) Table of Components

Clause 9.4.3.4.3

The FDR will contain a table that lists the major components of each Host System and the Tested Storage Configuration (TSC). Table 9-10 specifies the content, format, and appearance of the table.

The Host System and TSC table of components may be found on page 16 *(Benchmark Configuration/Tested Storage Configuration / Priced Storage Configuration Components).*

Customer Tunable Parameters and Options

Clause 9.4.3.5.1

All Benchmark Configuration (BC) components with customer tunable parameter and options that have been altered from their default values must be listed in the FDR. The FDR entry for each of those components must include both the name of the component and the altered value of the parameter or

option. If the parameter name is not self-explanatory to a knowledgeable practitioner, a brief description of the parameter's use must also be included in the FDR entry.

"Appendix B: Customer Tunable Parameters and Options" on page 62 contains the customer tunable parameters and options that have been altered from their default values for this benchmark.

Tested Storage Configuration (TSC) Description

Clause 9.4.3.5.2

The FDR must include sufficient information to recreate the logical representation of the TSC. In addition to customer tunable parameters and options (Clause 4.2.4.5.3), that information must include, at a minimum:

- *A diagram and/or description of the following:*
  - *All physical components that comprise the TSC. Those components are also illustrated in the BC Configuration Diagram in Clause 9.2.4.4.1 and/or the Storage Network Configuration Diagram in Clause 9.2.4.4.2.*
  - *The logical representation of the TSC, configured from the above components that will be presented to the Workload Generator.*
- *Listings of scripts used to create the logical representation of the TSC.*
- *If scripts were not used, a description of the process used with sufficient detail to recreate the logical representation of the TSC.*

"Appendix C: Tested Storage Configuration (TSC) Creation" on page 75 contains the detailed information that describes how to create and configure the logical TSC.

SPC-1 Workload Generator Storage Configuration

Clause 9.4.3.5.3

The FDR must include all SPC-1 Workload Generator storage configuration commands and parameters.

The SPC-1 Workload Generator storage configuration commands and parameters for this measurement appear in "Appendix D: SPC-1 Workload Generator Storage Commands and Parameters" on page 96.

SPC-1 DATA REPOSITORY

This portion of the Full Disclosure Report presents the detailed information that fully documents the various SPC-1 storage capacities and mappings used in the Tested Storage Configuration. "SPC-1 Data Repository Definitions" on page 58 contains definitions of terms specific to the SPC-1 Data Repository.

Storage Capacities and Relationships

Clause 9.4.3.6.1

Two tables and an illustration documenting the storage capacities and relationships of the SPC-1 Storage Hierarchy (Clause 2.1) shall be included in the FDR.

SPC-1 Storage Capacities

SPC-1 Storage Capacities		
Storage Hierarchy Component	**Units**	**Capacity**
Total ASU Capacity	Gigabytes (GB)	5,355.400
Addressable Storage Capacity	Gigabytes (GB)	5,610.301
Configured Storage Capacity	Gigabytes (GB)	19,018.652
Physical Storage Capacity	Gigabytes (GB)	19,389.500
Data Protection *(Mirroring)*	Gigabytes (GB)	5,610.301
Required Storage *(overhead/metadata/spares)*	Gigabytes (GB)	331.518
Global Storage Overhead	Gigabytes (GB)	370.848
Total Unused Storage	Gigabytes (GB)	7,976.334

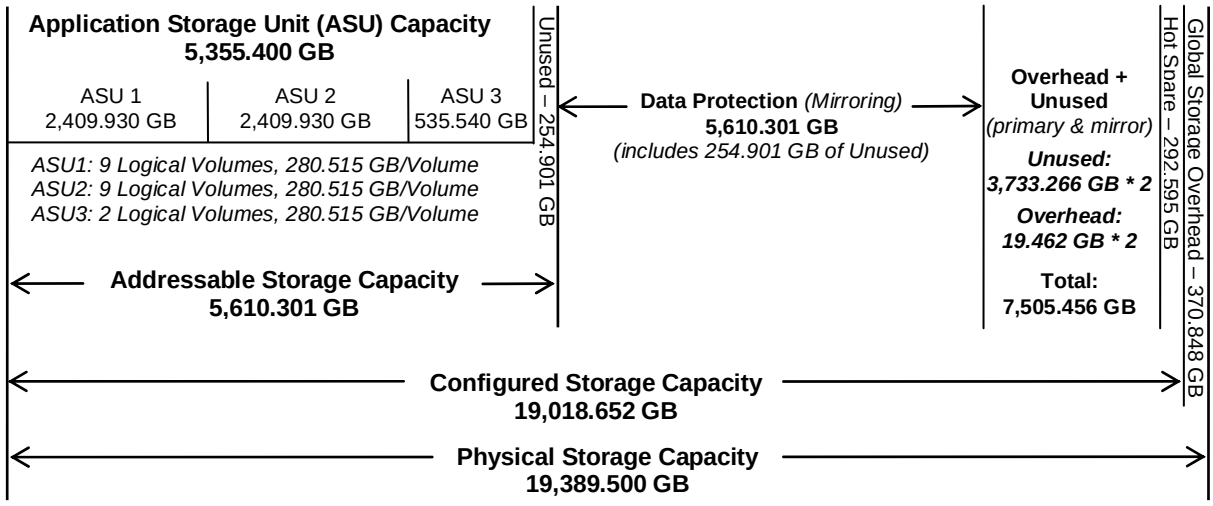
SPC-1 Storage Hierarchy Ratios

	Addressable Storage Capacity	**Configured Storage Capacity**	**Physical Storage Capacity**
Total ASU Capacity	95.46%	28.16%	27.62%
Required for Data Protection *(Mirrored)*		29.50%	28.93%
Addressable Storage Capacity		29.50%	28.93%
Required Storage *(overhead/metadata/spares)*		1.74%	1.71%
Configured Storage Capacity			98.09%
Global Storage Overhead			1.91%
Unused Storage:			
Addressable	4.54%		
Configured		39.26%	
Physical			0.00%

The Physical Storage Capacity consisted of 19,389.500 GB distributed over 65 disk drives each with a formatted capacity of 298.300 GB. There was 0.000 GB (0.00%) of Unused Storage within the Physical Storage Capacity. Global Storage Overhead consisted of 370.848 GB (1.91%) of Physical Storage Capacity. There was 7,466.532 GB (39.26%) of Unused Storage within the Configured Storage Capacity. The Total ASU Capacity utilized 95.46% of the Addressable Storage Capacity resulting in 254.901 GB (4.54%) of Unused Storage within the Addressable Storage Capacity. The Data Protection *(mirroring)* capacity was 5,610.301 GB of which 5,355.400 GB was utilized. The total Unused Storage was 7,976 GB.

SPC-1 Storage Capacities and Relationships Illustration

The various storage capacities configured in the benchmark result are illustrated below (not to scale).



Logical Volume Capacity and ASU Mapping

Clause 9.4.3.6.3

A table illustrating the capacity of each ASU and the mapping of Logical Volumes to ASUs shall be provided in the FDR. … Logical Volumes shall be sequenced in the table from top to bottom per its position in the contiguous address space of each ASU. The capacity of each Logical Volume shall be stated. … In conjunction with this table, the Test Sponsor shall provide a complete description of the type of data protection (see Clause 2.4.5) used on each Logical Volume.

Logical Volume Capacity and Mapping		
ASU-1 (2,409.930 GB)	**ASU-2 (2,409.930 GB)**	**ASU-3 (35.540 GB)**
9 Logical Volumes 280.515 GB per Logical Volume (267.770 GB used per Logical Volume)	9 Logical Volumes 280.515 GB per Logical Volume (267.770 GB used per Logical Volume)	2 Logical Volumes 280.515 GB per Logical Volume (267.770 GB used per Logical Volume)

The Data Protection Level used for all Logical Volumes was "Mirrored" as described on page 11. See "ASU Configuration" in the **IOPS Test Results File** for more detailed configuration information.

Storage Capacity Utilization

Clause 9.4.3.6.2

The FDR will include a table illustrating the storage capacity utilization values defined for Application Utilization (Clause 2.8.1), Protected Application Utilization (Clause 2.8.2), and Unused Storage Ratio (Clause 2.8.3).

Clause 2,8.1

Application Utilization is defined as Total ASU Capacity divided by Physical Storage Capacity.

Clause 2,8.2

Protected Application Utilization is defined as (Total ASU Capacity plus total Data Protection Capacity minus unused Data Protection Capacity) divided by Physical Storage Capacity.

Clause 2,8.3

Unused Storage Ratio is defined as Total Unused Capacity divided by Physical Storage Capacity and may not exceed 45%.

SPC-1 Storage Capacity Utilization	
Application Utilization	27.62%
Protected Application Utilization	55.24%
Unused Storage Ratio	41.14%

Assignment of RAID Groups and LUNs

The 32 RAID Group Assignments are RAID1(1+1) sets, each divided into 20 Logical Volumes, for a total of 640 LVs.

The RAID Group assignments to drives in the array are illustrated by the following chart.

Drive:	11 10	9 8	7 6	5 4	3 2	1 0
CE-00	RG-5	RG-4	RG-3	RG-2	RG-1	RG-0
DE-01	RG-B	RG-A	RG-9	RG-8	RG-7	RG-6
DE-02	RG-11	RG-10	RG-F	RG-E	RG-D	RG-C
DE-03	RG-17	RG-16	RG-15	RG-14	RG-13	RG-12
DE-04	RG-1D	RG-1C	RG-1B	RG-1A	RG-19	RG-18
DE-05				HS	RG-1F	RG-1E

System/Data Drives
Hot Spare Drive
Empty drive slots

The RAID Groups and LUN assignments are set up through a series of actions on the GUI Management Interface (ETERNUS Administrator). The task of setting up the configuration for each customer is provided as part of the base system price by Fujitsu. Different techniques are applied, depending upon the needs of the customer. This configuration reflects the customary techniques that are applied when a high performance requirement dominates the customer environment. Other techniques are applied when the primary requirement is for maximum capacity. In the case of high performance, it is customary to define RAID Groups arranged in RAID1 configurations. In this configuration, all of the RAID Groups are 1+1 arrangements. Please see page 75 *"Appendix C: Tested Storage Configuration (TSC) Creation"* for further details on preparing the configuration.

There is one (1) Hot Spare drive that has been included in the configuration. There are seven (7) empty drive slots in this configuration, as well.

The 640 Logical Volumes are grouped into four separate sets of LUNs, using LUN Port Mapping, each with 160 LUNs. These are connected to the logical host server through the 4 CA ports and directly connected HBA ports. The LUNs, seen through the four HBA ports by Solaris, are grouped into Solaris Volume Groups, and used with 8 MB stripe unit depths across the sets. Nine Logical Volumes, each with 32 LUNs are used for ASU1 and another nine for ASU2, while two Volumes, also each with 32 LUNs are used for ASU3. The sizes are reflected in the ASU Logical Volume Mapping chart.

Two optional facilities in the ETERNUS DX80 (GRPM and Trace), which are used to collect information during operation, were turned off during this benchmark run. They are normally not enabled during operations. Two secondary enhanced reliability features (Patrol and sampled Read after Write compare), which may be optionally enabled by a customer, were turned off during this benchmark run. The optional encryption feature was turned off during this benchmark, as well. Due to the transaction nature of the workload, as is customary for such workloads, the write sequential feature was turned off.

SPC-1 BENCHMARK EXECUTION RESULTS

This portion of the Full Disclosure Report documents the results of the various SPC-1 Tests, Test Phases, and Test Runs. "SPC-1 Test Execution Definitions" on page 59 contains definitions of terms specific to the SPC-1 Tests, Test Phases, and Test Runs.

Clause 5.4.3

The Tests must be executed in the following sequence: Primary Metrics, Repeatability, and Data Persistence. That required sequence must be uninterrupted from the start of Primary Metrics to the completion of Persistence Test Run 1. Uninterrupted means the Benchmark Configuration shall not be power cycled, restarted, disturbed, altered, or adjusted during the above measurement sequence. If the required sequence is interrupted other than for the Host System/TSC power cycle between the two Persistence Test Runs, the measurement is invalid.

SPC-1 Tests, Test Phases, and Test Runs

The SPC-1 benchmark consists of the following Tests, Test Phases, and Test Runs:

- **Primary Metrics Test**
  - Sustainability Test Phase and Test Run
  - IOPS Test Phase and Test Run
  - Response Time Ramp Test Phase
    - 95% of IOPS Test Run
    - 90% of IOPS Test Run
    - 80% of IOPS Test Run
    - 50% of IOPS Test Run
    - 10% of IOPS Test Run (LRT)
- **Repeatability Test**
  - Repeatability Test Phase 1
    - 10% of IOPS Test Run (LRT)
    - IOPS Test Run
  - Repeatability Test Phase 2
    - 10% of IOPS Test Run (LRT)
    - IOPS Test Run
- **Data Persistence Test**
  - Data Persistence Test Run 1
  - Data Persistence Test Run 2

Each Test is an atomic unit that must be executed from start to finish before any other Test, Test Phase, or Test Run may be executed.

The results from each Test, Test Phase, and Test Run are listed below along with a more detailed explanation of each component.

Primary Metrics Test – Sustainability Test Phase

Clause 5.4.4.1.1

The Sustainability Test Phase has exactly one Test Run and shall demonstrate the maximum sustainable I/O Request Throughput within at least a continuous three (3) hour Measurement Interval. This Test Phase also serves to insure that the TSC has reached Steady State prior to reporting the final maximum I/O Request Throughput result (SPC-1 IOPS™).

Clause 5.4.4.1.2

The computed I/O Request Throughput of the Sustainability Test must be within 5% of the reported SPC-1 IOPS™ result.

Clause 5.4.4.1.4

The Average Response Time, as defined in Clause 5.1.1, will be computed and reported for the Sustainability Test Run and cannot exceed 30 milliseconds. If the Average Response time exceeds that 30-milliseconds constraint, the measurement is invalid.

Clause 9.4.3.7.1

For the Sustainability Test Phase the FDR shall contain:

1. *A Data Rate Distribution graph and data table.*
2. *I/O Request Throughput Distribution graph and data table.*
3. *A Response Time Frequency Distribution graph and table.*
4. *An Average Response Time Distribution graph and table.*
5. *The human readable Test Run Results File produced by the Workload Generator (may be included in an appendix).*
6. *A listing or screen image of all input parameters supplied to the Workload Generator (may be included in an appendix).*
7. *The Measured Intensity Multiplier for each I/O stream.*
8. *The variability of the Measured Intensity Multiplier, as defined in Clause 5.3.13.3.*

SPC-1 Workload Generator Input Parameters

The SPC-1 Workload Generator input parameters for the Sustainability, IOPS, Response Time Ramp, Repeatability, and Persistence Test Runs are documented in "Appendix E: SPC-1 Workload Generator Input Parameters" on Page 97.

Sustainability Test Results File

A link to the test results file generated from the Sustainability Test Run is listed below.

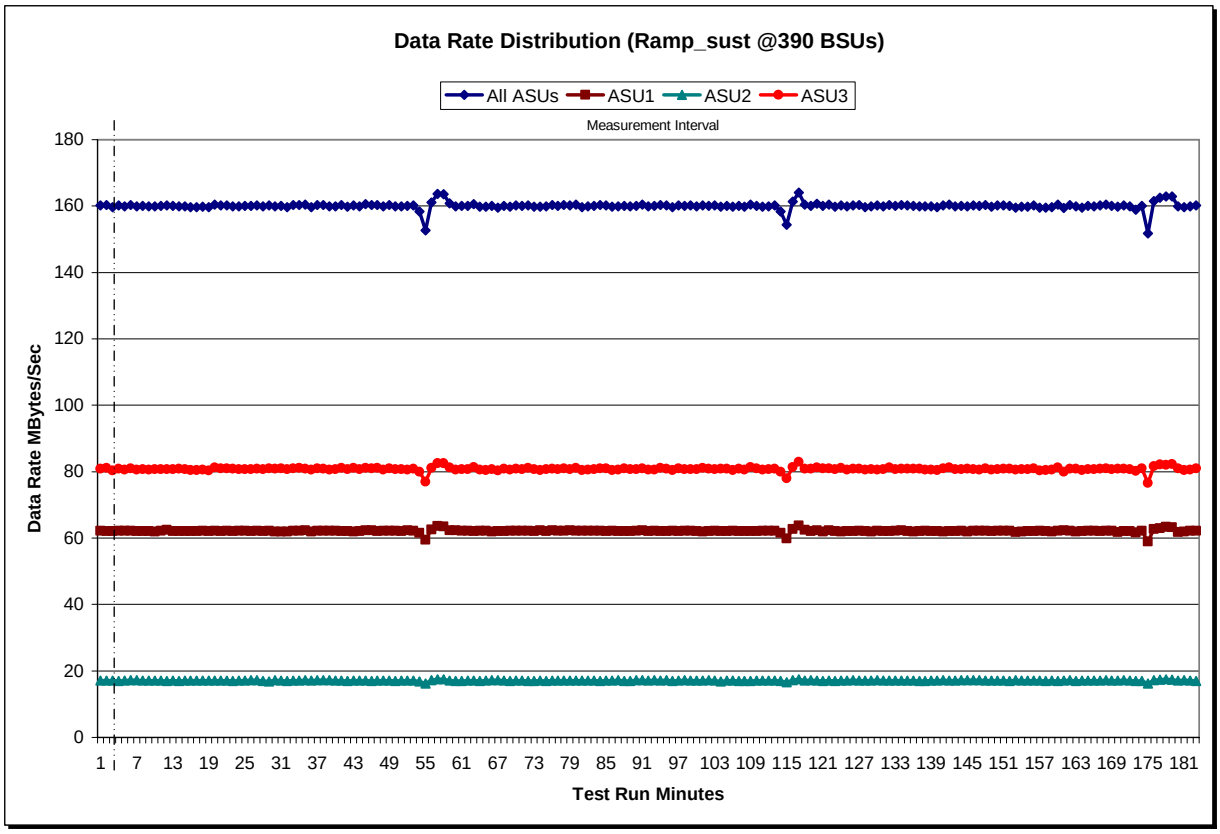
Sustainability Test Results File

Sustainability – Data Rate Distribution Data *(MB / second)*

	Start	Stop	Interval	Duration
Ramp-Up/Start-Up	10:54:35	10:57:35	0-2	0:03:00
Measurement Interval	10:57:35	13:57:35	3-182	3:00:00

Interval	All ASUs	ASU1	ASU2	ASU3	Interval	All ASUs	ASU1	ASU2	ASU3	Interval	All ASUs	ASU1	ASU2	ASU3
0	160.14	62.23	17.06	80.85	63	159.74	62.18	16.97	80.59	126	160.27	62.24	17.15	80.89
1	160.33	62.09	17.13	81.11	64	159.81	62.22	17.14	80.46	127	159.70	62.04	17.05	80.61
2	159.67	62.13	17.17	80.38	65	159.99	62.01	17.22	80.76	128	159.87	62.00	17.09	80.78
3	160.17	62.24	17.03	80.91	66	159.58	62.03	17.18	80.37	129	160.15	62.24	17.28	80.62
4	159.91	62.19	17.09	80.63	67	160.07	62.05	17.12	80.90	130	159.91	62.10	17.12	80.69
5	160.35	62.17	17.22	80.97	68	159.76	62.17	17.03	80.57	131	160.36	62.06	17.06	81.24
6	159.88	62.02	17.24	80.63	69	160.15	62.14	17.14	80.87	132	160.05	62.22	17.14	80.69
7	160.02	62.12	17.13	80.78	70	160.03	62.25	17.04	80.73	133	160.26	62.37	17.07	80.81
8	159.92	62.12	17.14	80.66	71	160.24	62.16	17.00	81.07	134	160.13	62.12	17.16	80.86
9	159.88	61.99	17.11	80.78	72	159.79	62.01	17.01	80.77	135	160.02	62.01	17.15	80.86
10	159.99	62.16	17.09	80.74	73	159.79	62.31	17.05	80.43	136	159.95	62.13	16.99	80.84
11	160.16	62.44	16.94	80.78	74	159.87	62.12	17.02	80.73	137	159.89	62.24	17.03	80.63
12	160.02	62.11	17.12	80.78	75	160.33	62.37	17.08	80.87	138	159.86	62.09	17.11	80.65
13	159.97	62.05	17.03	80.89	76	160.04	62.15	17.10	80.80	139	159.63	62.09	17.07	80.47
14	159.89	62.10	17.08	80.71	77	160.34	62.24	17.15	80.95	140	160.16	61.95	17.17	81.03
15	159.66	62.09	17.15	80.42	78	160.13	62.33	17.13	80.67	141	160.38	62.10	17.07	81.20
16	159.60	62.04	17.05	80.51	79	160.42	62.22	17.04	81.15	142	159.86	62.03	17.09	80.73
17	159.84	62.15	17.07	80.62	80	159.72	62.14	17.10	80.48	143	160.10	62.18	17.17	80.75
18	159.66	62.11	17.17	80.39	81	159.96	62.23	17.15	80.58	144	159.90	61.92	17.18	80.80
19	160.46	62.15	17.05	81.25	82	160.03	62.19	17.10	80.74	145	160.20	62.26	17.20	80.74
20	160.14	62.01	17.13	80.99	83	160.25	62.20	17.00	81.06	146	160.09	62.21	17.22	80.66
21	160.20	62.18	17.08	80.95	84	160.22	62.12	17.12	80.97	147	160.32	62.25	17.11	80.96
22	159.90	62.05	16.96	80.89	85	159.81	62.18	17.11	80.52	148	159.82	62.12	17.14	80.57
23	159.87	62.14	17.04	80.69	86	159.94	62.11	17.21	80.62	149	160.14	62.24	17.17	80.73
24	160.08	62.17	17.15	80.75	87	160.02	62.03	17.03	80.97	150	160.12	62.16	17.09	80.87
25	160.02	62.08	17.21	80.73	88	159.86	62.13	17.03	80.71	151	159.99	62.16	17.02	80.82
26	160.21	62.22	17.18	80.81	89	160.10	62.20	17.20	80.70	152	159.56	61.83	17.17	80.56
27	159.90	62.13	17.00	80.77	90	160.47	62.34	17.19	80.95	153	159.81	61.95	17.16	80.70
28	160.13	62.18	16.91	81.03	91	159.86	62.11	17.15	80.60	154	159.82	62.06	17.04	80.72
29	159.97	61.98	17.18	80.81	92	160.07	62.22	17.25	80.60	155	160.17	62.07	17.07	81.04
30	160.07	61.91	17.11	81.04	93	160.27	62.10	17.09	81.08	156	159.54	62.15	17.10	80.30
31	159.59	61.90	16.92	80.77	94	160.22	62.13	17.19	80.89	157	159.59	62.07	17.00	80.52
32	160.36	62.22	17.16	80.98	95	159.61	62.26	16.92	80.43	158	159.66	61.99	17.10	80.58
33	160.31	62.15	17.06	81.10	96	160.17	62.12	17.11	80.94	159	160.48	62.23	17.04	81.21
34	160.42	62.36	17.21	80.85	97	160.07	62.14	17.17	80.75	160	159.34	62.33	17.08	79.94
35	159.63	62.00	17.07	80.55	98	160.12	62.20	17.13	80.78	161	160.30	62.23	17.18	80.88
36	160.28	62.15	17.19	80.94	99	159.92	62.11	17.10	80.71	162	159.93	62.01	17.04	80.89
37	160.28	62.26	17.18	80.84	100	160.15	61.94	17.07	81.15	163	159.52	62.04	17.05	80.42
38	159.94	62.20	17.19	80.55	101	160.03	62.01	17.19	80.82	164	160.00	62.16	17.07	80.77
39	159.96	62.15	17.14	80.67	102	160.15	62.25	17.12	80.78	165	159.95	62.16	17.08	80.72
40	160.37	62.04	17.14	81.19	103	159.81	62.13	16.86	80.82	166	160.22	62.13	17.17	80.92
41	159.84	62.07	17.04	80.72	104	159.99	62.07	17.12	80.80	167	160.41	62.20	17.23	80.98
42	160.12	61.97	17.06	81.08	105	159.73	62.18	17.13	80.42	168	160.08	62.21	17.12	80.76
43	159.97	62.08	17.09	80.80	106	159.98	62.14	16.98	80.86	169	159.80	61.85	17.12	80.82
44	160.50	62.30	17.09	81.12	107	159.77	62.11	17.01	80.65	170	160.18	62.06	17.22	80.90
45	160.29	62.32	17.03	80.94	108	160.47	62.07	17.04	81.36	171	159.88	62.11	17.07	80.70
46	160.26	62.09	17.07	81.10	109	160.00	62.02	17.04	80.94	172	158.92	61.75	16.97	80.21
47	159.86	62.17	17.05	80.65	110	159.82	62.22	17.06	80.55	173	160.05	62.17	16.94	80.94
48	160.31	62.21	17.12	80.98	111	159.96	62.19	17.10	80.68	174	151.71	58.92	16.26	76.53
49	159.90	62.16	17.02	80.72	112	160.16	62.15	17.12	80.89	175	161.52	62.70	17.24	81.58
50	159.94	62.10	17.10	80.75	113	158.34	61.51	16.93	79.91	176	162.49	62.97	17.34	82.18
51	160.00	62.27	17.13	80.60	114	154.37	59.86	16.52	77.98	177	162.92	63.34	17.51	82.06
52	160.15	62.14	17.09	80.92	115	161.32	62.77	17.21	81.33	178	162.83	63.18	17.42	82.24
53	158.39	61.56	16.84	79.99	116	164.05	63.73	17.44	82.89	179	159.90	61.83	17.08	80.99
54	152.69	59.50	16.26	76.93	117	160.46	62.48	17.15	80.83	180	159.60	61.96	17.21	80.44
55	161.05	62.60	17.29	81.15	118	160.08	62.06	17.21	80.81	181	159.87	62.20	17.10	80.57
56	163.65	63.67	17.43	82.55	119	160.66	62.32	17.14	81.20	182	160.16	62.14	17.04	80.98
57	163.54	63.46	17.54	82.54	120	159.99	62.01	16.93	81.05					
58	160.76	62.31	17.16	81.29	121	160.46	62.34	17.08	81.05					
59	159.88	62.29	16.95	80.64	122	159.81	62.08	17.01	80.72					
60	160.02	62.21	17.02	80.79	123	160.19	61.95	17.11	81.13					
61	160.02	62.26	17.05	80.72	124	159.86	62.12	17.10	80.65					
62	160.59	62.12	17.12	81.35	125	160.12	62.02	17.20	80.90					

Sustainability – Data Rate Distribution Graph

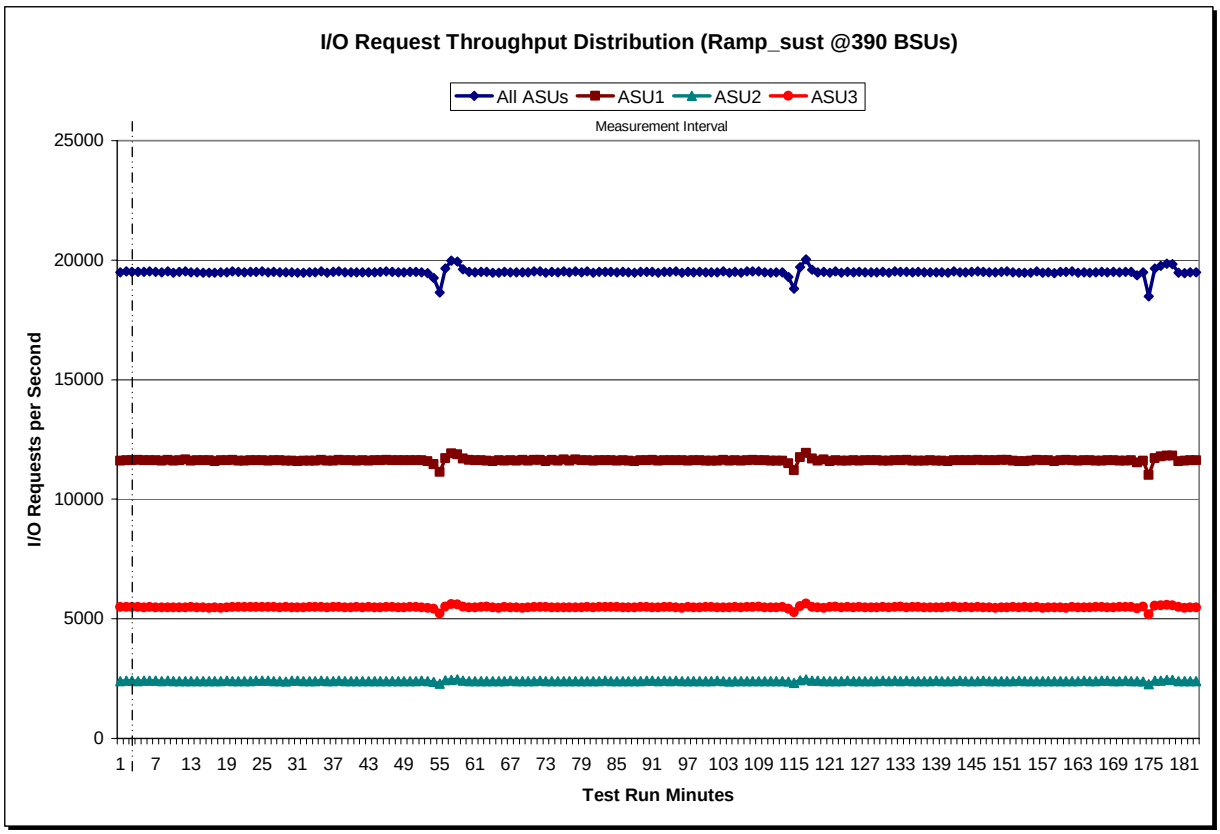


Sustainability – I/O Request Throughput Distribution Data

	Start	Stop	Interval	Duration
Ramp-Up/Start-Up	10:54:35	10:57:35	0-2	0:03:00
Measurement Interval	10:57:35	13:57:35	3-182	3:00:00

Interval	All ASUs	ASU1	ASU2	ASU3	Interval	All ASUs	ASU1	ASU2	ASU3	Interval	All ASUs	ASU1	ASU2	ASU3
0	19,491.62	11,610.37	2,395.48	5,485.77	63	19,477.62	11,597.73	2,402.77	5,477.12	126	19,495.28	11,621.10	2,401.05	5,473.13
1	19,528.13	11,621.82	2,408.65	5,497.67	64	19,475.45	11,618.20	2,397.55	5,459.70	127	19,494.80	11,628.08	2,400.48	5,466.23
2	19,518.22	11,626.53	2,410.92	5,480.77	65	19,504.95	11,612.93	2,401.18	5,490.83	128	19,497.52	11,630.03	2,394.23	5,473.25
3	19,511.77	11,642.27	2,388.57	5,480.93	66	19,495.02	11,619.65	2,403.70	5,471.67	129	19,517.87	11,618.07	2,405.37	5,494.43
4	19,501.75	11,625.08	2,404.42	5,472.25	67	19,489.00	11,611.50	2,398.13	5,479.37	130	19,481.52	11,611.87	2,396.87	5,472.78
5	19,537.32	11,632.30	2,411.75	5,493.27	68	19,485.52	11,638.18	2,389.10	5,458.23	131	19,520.93	11,623.83	2,403.17	5,493.93
6	19,511.77	11,625.93	2,406.20	5,479.63	69	19,484.42	11,612.85	2,398.10	5,473.47	132	19,510.30	11,621.47	2,389.80	5,499.03
7	19,487.50	11,614.97	2,398.77	5,473.77	70	19,519.90	11,639.08	2,399.97	5,480.85	133	19,518.30	11,644.15	2,405.93	5,468.22
8	19,523.10	11,646.48	2,406.38	5,470.23	71	19,522.15	11,637.47	2,403.05	5,481.63	134	19,499.53	11,612.30	2,389.67	5,497.57
9	19,482.42	11,609.07	2,399.68	5,473.67	72	19,476.33	11,598.88	2,394.15	5,483.30	135	19,505.75	11,614.77	2,402.13	5,488.85
10	19,509.03	11,632.58	2,398.67	5,477.78	73	19,506.65	11,638.42	2,396.93	5,471.30	136	19,487.23	11,610.05	2,399.48	5,477.70
11	19,520.52	11,655.48	2,391.37	5,473.67	74	19,483.60	11,616.23	2,394.92	5,472.45	137	19,488.45	11,628.18	2,392.72	5,467.55
12	19,483.73	11,601.37	2,400.87	5,481.50	75	19,524.95	11,654.47	2,395.63	5,474.85	138	19,484.40	11,611.72	2,403.97	5,468.72
13	19,490.35	11,618.10	2,394.03	5,478.22	76	19,489.18	11,615.47	2,395.07	5,478.65	139	19,487.90	11,610.73	2,397.53	5,479.63
14	19,481.38	11,618.62	2,388.80	5,473.97	77	19,532.78	11,654.85	2,399.37	5,478.57	140	19,474.63	11,593.88	2,400.18	5,480.57
15	19,477.48	11,619.92	2,398.03	5,459.53	78	19,499.92	11,631.25	2,391.82	5,476.85	141	19,526.88	11,618.53	2,399.18	5,509.17
16	19,471.10	11,598.02	2,395.12	5,477.97	79	19,519.95	11,630.63	2,399.53	5,489.78	142	19,493.00	11,620.85	2,403.65	5,468.50
17	19,488.83	11,632.63	2,396.68	5,459.52	80	19,472.90	11,610.63	2,399.12	5,463.15	143	19,495.13	11,622.37	2,389.67	5,483.10
18	19,497.65	11,628.30	2,403.28	5,466.07	81	19,514.12	11,635.42	2,395.43	5,483.27	144	19,504.12	11,624.08	2,402.30	5,477.73
19	19,522.02	11,637.52	2,394.27	5,490.23	82	19,512.05	11,622.28	2,403.62	5,486.15	145	19,530.13	11,651.33	2,397.23	5,481.57
20	19,506.42	11,616.47	2,396.72	5,493.23	83	19,517.87	11,625.17	2,399.25	5,493.45	146	19,514.97	11,622.10	2,417.48	5,475.38
21	19,487.52	11,600.25	2,401.10	5,486.17	84	19,493.88	11,610.22	2,398.55	5,485.12	147	19,499.60	11,629.82	2,393.28	5,476.50
22	19,509.88	11,631.32	2,394.03	5,484.53	85	19,510.05	11,634.17	2,400.53	5,475.35	148	19,484.87	11,628.95	2,394.50	5,461.42
23	19,509.23	11,618.08	2,407.30	5,483.85	86	19,489.70	11,611.70	2,397.88	5,480.12	149	19,516.98	11,639.95	2,396.67	5,480.37
24	19,521.13	11,628.02	2,404.92	5,488.20	87	19,470.85	11,595.52	2,398.88	5,476.45	150	19,527.13	11,644.63	2,402.10	5,480.40
25	19,499.93	11,609.28	2,407.22	5,483.43	88	19,513.67	11,627.43	2,398.62	5,487.62	151	19,496.33	11,611.10	2,394.92	5,490.32
26	19,509.00	11,625.25	2,401.50	5,482.25	89	19,511.12	11,621.27	2,406.55	5,483.30	152	19,476.58	11,594.75	2,412.07	5,469.77
27	19,492.05	11,624.12	2,391.23	5,476.70	90	19,512.47	11,644.40	2,403.28	5,464.78	153	19,469.60	11,585.43	2,398.53	5,485.63
28	19,488.18	11,615.02	2,380.72	5,492.45	91	19,468.43	11,608.67	2,393.08	5,466.68	154	19,476.60	11,611.72	2,397.13	5,467.75
29	19,485.28	11,605.10	2,404.52	5,475.67	92	19,517.02	11,622.67	2,405.60	5,488.75	155	19,525.13	11,639.53	2,397.25	5,488.35
30	19,478.85	11,594.78	2,404.42	5,479.65	93	19,505.22	11,622.15	2,393.50	5,489.57	156	19,478.88	11,618.55	2,402.32	5,458.02
31	19,475.03	11,606.97	2,387.98	5,480.08	94	19,519.57	11,633.52	2,415.70	5,470.35	157	19,485.25	11,623.02	2,388.25	5,473.98
32	19,494.80	11,615.47	2,390.62	5,488.72	95	19,480.05	11,631.08	2,390.93	5,458.03	158	19,456.45	11,582.57	2,398.63	5,475.25
33	19,494.73	11,614.08	2,396.57	5,484.08	96	19,503.27	11,608.68	2,397.57	5,497.02	159	19,501.90	11,627.25	2,394.37	5,480.28
34	19,536.12	11,645.83	2,407.32	5,482.97	97	19,495.32	11,618.83	2,397.65	5,478.83	160	19,509.02	11,653.23	2,394.28	5,461.50
35	19,482.33	11,612.02	2,398.90	5,471.42	98	19,509.45	11,633.35	2,401.75	5,474.35	161	19,522.93	11,632.77	2,402.02	5,488.15
36	19,504.62	11,616.38	2,401.25	5,486.98	99	19,486.32	11,608.93	2,393.70	5,483.68	162	19,480.43	11,611.98	2,394.32	5,474.13
37	19,521.52	11,636.87	2,403.77	5,480.88	100	19,496.28	11,601.03	2,399.80	5,495.45	163	19,501.23	11,618.48	2,410.52	5,472.23
38	19,498.18	11,633.75	2,397.92	5,466.52	101	19,495.55	11,614.67	2,405.47	5,475.42	164	19,481.17	11,623.38	2,389.52	5,468.27
39	19,499.55	11,627.75	2,400.28	5,471.52	102	19,522.08	11,653.37	2,398.38	5,470.33	165	19,487.62	11,608.18	2,396.95	5,482.48
40	19,496.08	11,603.88	2,397.50	5,494.70	103	19,471.07	11,615.57	2,381.98	5,473.52	166	19,518.70	11,615.75	2,407.40	5,495.55
41	19,496.65	11,623.85	2,402.02	5,470.78	104	19,512.77	11,623.42	2,402.40	5,486.95	167	19,496.58	11,619.43	2,404.32	5,472.83
42	19,493.57	11,610.90	2,399.50	5,483.17	105	19,475.30	11,611.48	2,396.38	5,467.43	168	19,501.85	11,631.50	2,399.93	5,470.42
43	19,493.45	11,626.67	2,395.80	5,470.98	106	19,520.47	11,624.72	2,401.55	5,494.20	169	19,495.07	11,606.55	2,399.18	5,489.33
44	19,512.80	11,635.75	2,399.88	5,477.17	107	19,521.28	11,637.10	2,393.90	5,490.28	170	19,508.12	11,614.03	2,404.13	5,489.95
45	19,524.12	11,639.47	2,401.28	5,483.37	108	19,533.02	11,631.43	2,401.77	5,499.82	171	19,509.25	11,620.02	2,399.87	5,489.37
46	19,508.00	11,624.37	2,393.17	5,490.47	109	19,499.62	11,621.93	2,400.63	5,477.05	172	19,361.40	11,544.73	2,388.68	5,427.98
47	19,496.33	11,622.73	2,398.27	5,475.33	110	19,480.38	11,617.75	2,396.15	5,466.48	173	19,486.65	11,602.98	2,381.53	5,502.13
48	19,497.57	11,623.27	2,398.52	5,475.78	111	19,490.10	11,617.87	2,393.57	5,478.67	174	18,484.13	11,023.93	2,271.72	5,188.48
49	19,504.07	11,626.42	2,392.33	5,485.32	112	19,486.43	11,607.75	2,395.80	5,482.88	175	19,652.55	11,709.53	2,408.23	5,534.78
50	19,514.78	11,625.63	2,402.65	5,486.50	113	19,290.55	11,494.65	2,373.18	5,422.72	176	19,770.50	11,784.50	2,420.38	5,565.62
51	19,492.97	11,624.40	2,405.23	5,463.33	114	18,808.75	11,208.92	2,317.65	5,282.18	177	19,855.05	11,823.65	2,453.13	5,578.27
52	19,448.67	11,591.70	2,394.48	5,462.48	115	19,712.23	11,760.87	2,425.98	5,525.38	178	19,832.78	11,823.38	2,439.47	5,569.93
53	19,252.78	11,472.68	2,364.90	5,415.20	116	20,028.28	11,928.63	2,458.33	5,641.32	179	19,482.50	11,596.85	2,400.50	5,485.15
54	18,648.28	11,134.05	2,286.43	5,227.80	117	19,603.52	11,699.83	2,415.72	5,487.97	180	19,456.92	11,607.40	2,392.98	5,456.53
55	19,650.95	11,712.52	2,424.73	5,513.70	118	19,494.85	11,617.12	2,404.85	5,472.88	181	19,484.73	11,631.75	2,385.72	5,467.27
56	19,978.58	11,917.17	2,454.55	5,606.87	119	19,507.93	11,657.87	2,391.93	5,458.13	182	19,500.85	11,626.20	2,398.72	5,475.93
57	19,940.05	11,880.77	2,459.90	5,599.38	120	19,481.08	11,598.63	2,393.87	5,488.58	Average	19,498.93	11,621.69	2,398.41	5,478.83
58	19,612.82	11,691.25	2,416.03	5,505.53	121	19,532.50	11,632.95	2,397.32	5,502.23					
59	19,507.57	11,643.98	2,389.47	5,474.12	122	19,480.38	11,609.80	2,395.35	5,475.23					
60	19,492.48	11,625.60	2,390.43	5,476.45	123	19,509.43	11,615.72	2,403.72	5,490.00					
61	19,502.90	11,623.32	2,393.63	5,485.95	124	19,488.22	11,628.77	2,393.10	5,466.35					
62	19,506.20	11,604.65	2,400.17	5,501.38	125	19,506.83	11,611.65	2,401.08	5,494.10					

Sustainability – I/O Request Throughput Distribution Graph

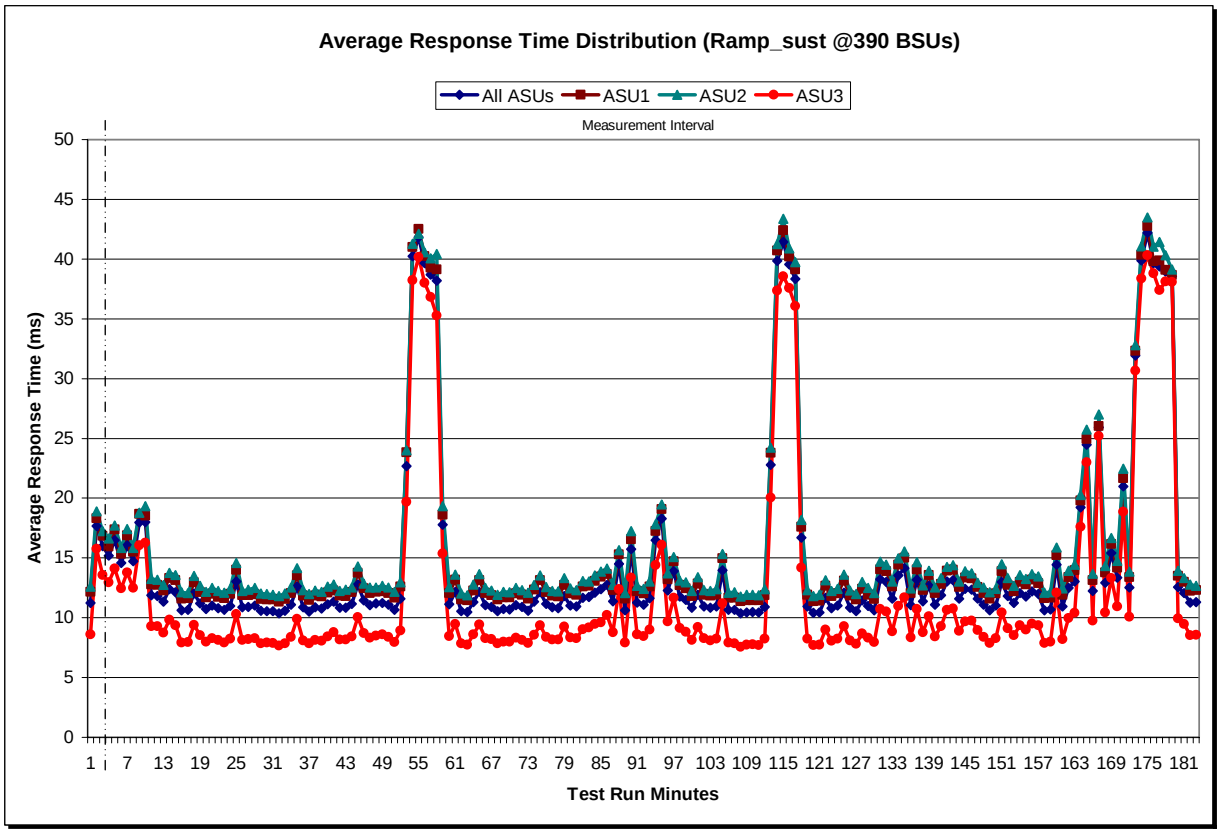


Sustainability – Average Response Time (ms) Distribution Data

	Start	Stop	Interval	Duration
Ramp-Up/Start-Up	10:54:35	10:57:35	0-2	0:03:00
Measurement Interval	10:57:35	13:57:35	3-182	3:00:00

Interval	All ASUs	ASU1	ASU2	ASU3	Interval	All ASUs	ASU1	ASU2	ASU3	Interval	All ASUs	ASU1	ASU2	ASU3
0	11.22	12.17	12.59	8.61	63	11.31	12.29	12.77	8.59	126	10.54	11.53	11.98	7.80
1	17.67	18.32	18.89	15.78	64	12.17	13.15	13.66	9.43	127	11.45	12.42	13.00	8.69
2	15.98	16.85	17.26	13.57	65	11.06	12.07	12.47	8.30	128	10.96	11.90	12.48	8.31
3	15.19	15.96	16.62	12.95	66	10.89	11.87	12.28	8.20	129	10.61	11.57	12.05	7.95
4	16.50	17.37	17.72	14.11	67	10.55	11.53	11.93	7.86	130	13.20	14.05	14.70	10.74
5	14.59	15.34	15.84	12.45	68	10.73	11.71	12.18	8.00	131	13.00	13.89	14.42	10.50
6	16.07	16.87	17.41	13.77	69	10.70	11.69	12.11	7.98	132	11.59	12.59	13.04	8.86
7	14.71	15.52	15.85	12.49	70	11.03	12.01	12.51	8.33	133	13.52	14.42	14.96	10.97
8	17.96	18.69	18.81	16.05	71	10.90	11.91	12.30	8.14	134	14.15	15.01	15.57	11.71
9	18.00	18.54	19.32	16.27	72	10.60	11.58	12.10	7.87	135	11.06	12.05	12.46	8.37
10	11.86	12.79	13.26	9.28	73	11.34	12.34	12.75	8.58	136	13.18	14.02	14.66	10.74
11	11.82	12.73	13.18	9.28	74	12.13	13.13	13.55	9.37	137	11.36	12.30	12.72	8.78
12	11.33	12.26	12.75	8.73	75	11.14	12.14	12.58	8.39	138	12.65	13.58	13.92	10.13
13	12.40	13.32	13.76	9.84	76	10.86	11.84	12.25	8.17	139	11.09	12.05	12.52	8.42
14	12.12	13.13	13.56	9.35	77	10.82	11.78	12.21	8.16	140	11.88	12.80	13.32	9.30
15	10.62	11.58	12.14	7.90	78	11.82	12.73	13.31	9.24	141	13.05	13.94	14.25	10.65
16	10.64	11.62	12.05	7.95	79	11.03	12.01	12.47	8.34	142	13.15	14.02	14.39	10.75
17	12.03	12.96	13.49	9.39	80	10.94	11.91	12.31	8.27	143	11.58	12.55	13.05	8.91
18	11.19	12.14	12.67	8.53	81	11.66	12.61	13.05	9.04	144	12.40	13.37	13.90	9.70
19	10.71	11.70	12.16	7.97	82	11.73	12.66	13.04	9.19	145	12.36	13.30	13.73	9.76
20	11.01	11.99	12.51	8.30	83	12.11	13.07	13.53	9.45	146	11.60	12.56	12.92	8.96
21	10.79	11.75	12.23	8.13	84	12.40	13.41	13.85	9.62	147	11.09	12.06	12.54	8.40
22	10.64	11.63	12.08	7.92	85	12.74	13.64	14.12	10.21	148	10.61	11.58	12.13	7.87
23	10.98	11.97	12.41	8.24	86	11.37	12.31	12.74	8.78	149	11.03	12.02	12.43	8.29
24	13.03	13.99	14.58	10.30	87	14.52	15.29	15.67	12.39	150	12.99	13.88	14.48	10.44
25	10.87	11.88	12.24	8.13	88	10.61	11.59	12.06	7.91	151	11.79	12.76	13.30	9.10
26	10.90	11.87	12.35	8.21	89	15.74	16.56	17.23	13.36	152	11.23	12.21	12.67	8.53
27	11.00	11.96	12.49	8.29	90	11.26	12.21	12.67	8.62	153	12.05	13.01	13.56	9.35
28	10.58	11.57	12.02	7.86	91	11.08	12.03	12.41	8.47	154	11.78	12.79	13.25	9.00
29	10.56	11.52	12.00	7.91	92	11.64	12.60	13.03	8.99	155	12.20	13.18	13.65	9.50
30	10.55	11.52	11.93	7.89	93	16.50	17.23	17.82	14.38	156	11.97	12.89	13.46	9.37
31	10.37	11.34	11.82	7.68	94	18.30	19.08	19.49	16.10	157	10.63	11.61	12.10	7.89
32	10.57	11.56	12.01	7.85	95	12.28	13.21	13.71	9.68	158	10.69	11.68	12.12	7.97
33	11.08	12.06	12.51	8.39	96	13.89	14.71	15.07	11.65	159	14.44	15.23	15.89	12.11
34	12.59	13.54	14.15	9.89	97	11.77	12.72	13.12	9.15	160	10.95	11.93	12.44	8.20
35	10.86	11.86	12.30	8.10	98	11.50	12.45	12.96	8.84	161	12.51	13.41	13.92	9.97
36	10.53	11.50	11.99	7.83	99	10.82	11.79	12.25	8.15	162	13.02	13.97	14.43	10.40
37	10.86	11.84	12.28	8.15	100	11.90	12.85	13.38	9.23	163	19.23	19.78	20.27	17.60
38	10.78	11.77	12.17	8.06	101	10.94	11.91	12.32	8.29	164	24.50	24.94	25.73	23.00
39	11.12	12.08	12.61	8.43	102	10.85	11.85	12.25	8.11	165	12.25	13.13	13.69	9.74
40	11.35	12.28	12.79	8.77	103	10.93	11.91	12.37	8.23	166	25.91	26.03	27.01	25.18
41	10.85	11.83	12.26	8.15	104	13.96	14.98	15.35	11.18	167	12.92	13.79	14.32	10.44
42	10.84	11.80	12.34	8.17	105	10.67	11.66	12.09	7.94	168	15.42	16.16	16.67	13.31
43	11.14	12.14	12.53	8.42	106	10.64	11.66	12.11	7.85	169	13.34	14.18	14.77	10.94
44	12.78	13.76	14.28	10.04	107	10.35	11.37	11.78	7.57	170	20.98	21.66	22.47	18.88
45	11.45	12.44	12.85	8.73	108	10.45	11.44	11.90	7.73	171	12.51	13.39	13.85	10.08
46	11.06	12.06	12.53	8.30	109	10.47	11.45	11.92	7.76	172	31.92	32.33	32.79	30.66
47	11.18	12.16	12.54	8.51	110	10.44	11.43	11.86	7.70	173	39.88	40.36	41.07	38.37
48	11.24	12.19	12.68	8.59	111	10.92	11.89	12.38	8.23	174	42.18	42.77	43.50	40.33
49	11.09	12.07	12.54	8.38	112	22.80	23.81	24.24	20.04	175	39.67	39.80	41.02	38.79
50	10.67	11.65	12.15	7.94	113	39.84	40.71	41.26	37.37	176	39.38	39.90	41.44	37.40
51	11.61	12.58	12.96	8.93	114	41.44	42.41	43.38	38.54	177	38.97	39.08	40.31	38.12
52	22.69	23.81	24.03	19.70	115	39.56	40.21	40.90	37.57	178	38.56	38.68	39.12	38.07
53	40.26	41.00	41.30	38.24	116	38.34	39.14	39.73	36.06	179	12.55	13.50	13.93	9.94
54	41.82	42.52	42.13	40.18	117	16.71	17.60	18.17	14.17	180	12.05	12.99	13.34	9.48
55	39.66	40.24	40.55	38.02	118	10.93	11.92	12.30	8.24	181	11.27	12.24	12.79	8.54
56	38.69	39.28	40.06	36.84	119	10.41	11.39	11.79	7.70	182	11.30	12.30	12.67	8.58
57	38.20	39.12	40.43	35.29	120	10.44	11.42	11.91	7.73	Average	14.70	15.60	16.10	12.17
58	17.79	18.61	19.32	15.36	121	11.68	12.65	13.13	8.99					
59	11.11	12.06	12.56	8.47	122	10.81	11.80	12.25	8.08					
60	12.18	13.16	13.62	9.47	123	11.01	12.02	12.44	8.26					
61	10.54	11.51	12.03	7.84	124	12.09	13.10	13.60	9.30					
62	10.47	11.46	11.88	7.75	125	10.84	11.84	12.29	8.09					

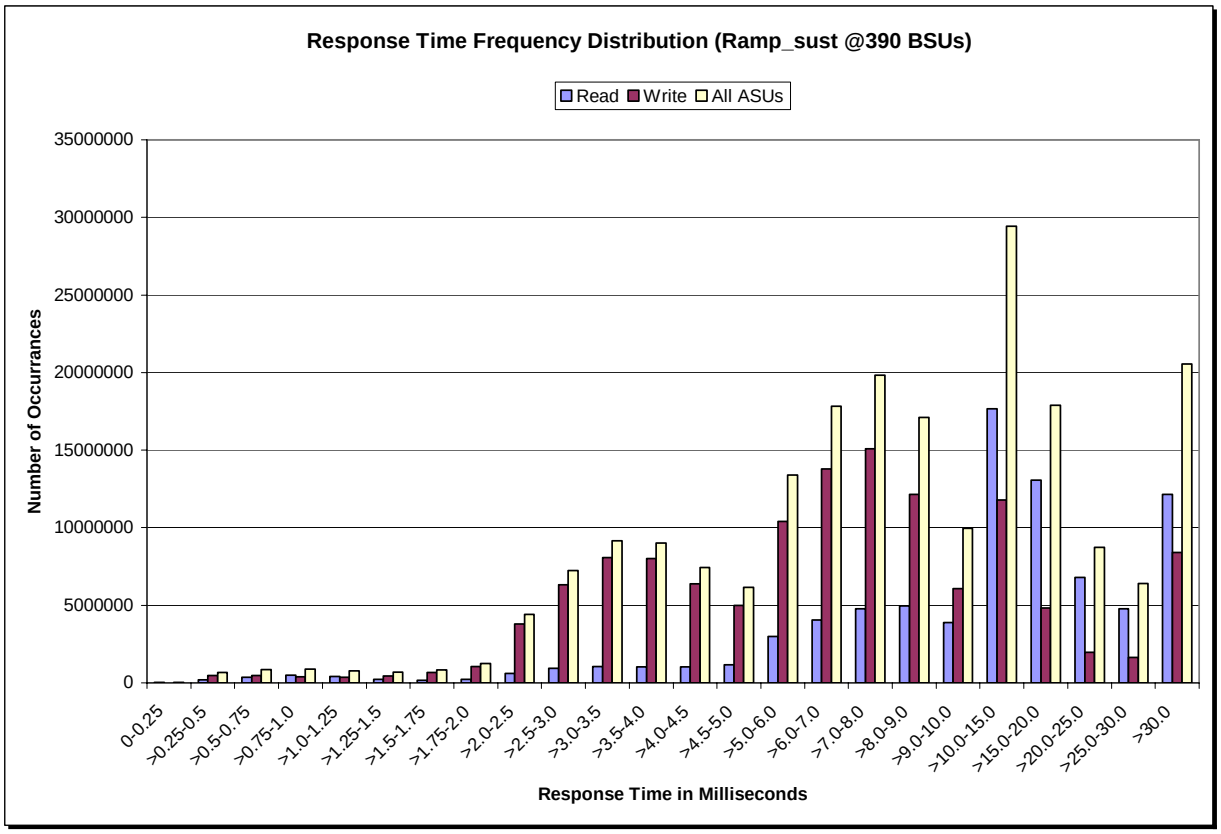
Sustainability – Average Response Time (ms) Distribution Graph



Sustainability – Response Time Frequency Distribution Data

Response Time (ms)	0-0.25	>0.25-0.5	>0.5-0.75	>0.75-1.0	>1.0-1.25	>1.25-1.5	>1.5-1.75	>1.75-2.0
Read	26,852	197,318	373,318	512,343	410,034	235,441	176,888	211,005
Write	6,128	473,722	473,245	387,810	369,703	445,466	657,014	1,041,259
All ASUs	32,980	671,040	846,563	900,153	779,737	680,907	833,902	1,252,264
ASU1	25,951	389,495	520,546	597,267	504,368	391,021	435,064	633,035
ASU2	4,545	82,829	112,805	126,300	109,284	92,796	110,395	163,691
ASU3	2,484	198,716	213,212	176,586	166,085	197,090	288,443	455,538
Response Time (ms)	**>2.0-2.5**	**>2.5-3.0**	**>3.0-3.5**	**>3.5-4.0**	**>4.0-4.5**	**>4.5-5.0**	**>5.0-6.0**	**>6.0-7.0**
Read	622,772	930,028	1,057,701	1,018,329	1,037,978	1,162,444	3,000,096	4,055,711
Write	3,790,384	6,313,573	8,080,852	8,005,318	6,382,113	5,004,661	10,397,210	13,774,724
All ASUs	4,413,156	7,243,601	9,138,553	9,023,647	7,420,091	6,167,105	13,397,306	17,830,435
ASU1	2,182,222	3,534,283	4,413,550	4,331,220	3,605,544	3,102,157	7,018,807	9,456,544
ASU2	568,367	925,995	1,132,649	1,069,472	855,825	704,165	1,547,950	2,067,193
ASU3	1,662,567	2,783,323	3,592,354	3,622,955	2,958,722	2,360,783	4,830,549	6,306,698
Response Time (ms)	**>7.0-8.0**	**>8.0-9.0**	**>9.0-10.0**	**>10.0-15.0**	**>15.0-20.0**	**>20.0-25.0**	**>25.0-30.0**	**>30.0**
Read	4,758,383	4,962,780	3,874,702	17,657,299	13,063,718	6,787,538	4,767,370	12,154,630
Write	15,082,359	12,152,053	6,079,422	11,774,332	4,837,407	1,956,684	1,639,203	8,408,871
All ASUs	19,840,742	17,114,833	9,954,124	29,431,631	17,901,125	8,744,222	6,406,573	20,563,501
ASU1	10,639,446	9,550,362	6,000,559	20,603,237	13,320,608	6,617,178	4,626,639	13,015,019
ASU2	2,282,360	1,957,723	1,141,940	3,337,697	2,210,166	1,164,824	924,224	3,209,594
ASU3	6,918,936	5,606,748	2,811,625	5,490,697	2,370,351	962,220	855,710	4,338,888

Sustainability – Response Time Frequency Distribution Graph



Sustainability – Measured Intensity Multiplier and Coefficient of Variation

Clause 3.4.3

IM – Intensity Multiplier: *The ratio of I/Os for each I/O stream relative to the total I/Os for all I/O streams (ASU1-1 – ASU3-1) as required by the benchmark specification.*

Clauses 5.1.10 and 5.3.13.2

MIM – Measured Intensity Multiplier: *The Measured Intensity Multiplier represents the ratio of measured I/Os for each I/O stream relative to the total I/Os measured for all I/O streams (ASU1-1 – ASU3-1). This value may differ from the corresponding Expected Intensity Multiplier by no more than 5%.*

Clause 5.3.13.3

COV – Coefficient of Variation: *This measure of variation for the Measured Intensity Multiplier cannot exceed 0.2.*

	ASU1-1	ASU1-2	ASU1-3	ASU1-4	ASU2-1	ASU2-2	ASU2-3	ASU3-1
IM	***0.0350***	***0.2810***	***0.0700***	***0.2100***	***0.0180***	***0.0700***	***0.0350***	***0.2810***
MIM	0.0350	0.2810	0.0700	0.2100	0.0180	0.0700	0.0350	0.2810
COV	0.005	0.002	0.003	0.002	0.007	0.003	0.005	0.002

Primary Metrics Test – IOPS Test Phase

Clause 5.4.4.2

The IOPS Test Phase consists of one Test Run at the 100% load point with a Measurement Interval of ten (10) minutes. The IOPS Test Phase immediately follows the Sustainability Test Phase without any interruption or manual intervention.

The IOPS Test Run generates the SPC-1 IOPS™ primary metric, which is computed as the I/O Request Throughput for the Measurement Interval of the IOPS Test Run.

The Average Response Time is computed for the IOPS Test Run and cannot exceed 30 milliseconds. If the Average Response Time exceeds the 30 millisecond constraint, the measurement is invalid.

Clause 9.4.3.7.2

For the IOPS Test Phase the FDR shall contain:

1. *I/O Request Throughput Distribution (data and graph).*
2. *A Response Time Frequency Distribution.*
3. *An Average Response Time Distribution.*
4. *The human readable Test Run Results File produced by the Workload Generator.*
5. *A listing or screen image of all input parameters supplied t the Workload Generator.*
6. *The total number of I/O Requests completed in the Measurement Interval as well as the number of I/O Requests with a Response Time less than or equal to 30 milliseconds and the number of I/O Requests with a Response Time greater than 30 milliseconds.*

SPC-1 Workload Generator Input Parameters

The SPC-1 Workload Generator input parameters for the Sustainability, IOPS, Response Time Ramp, Repeatability, and Persistence Test Runs are documented in "Appendix E: SPC-1 Workload Generator Input Parameters" on Page 97.

IOPS Test Results File

A link to the test results file generated from the IOPS Test Run is listed below.

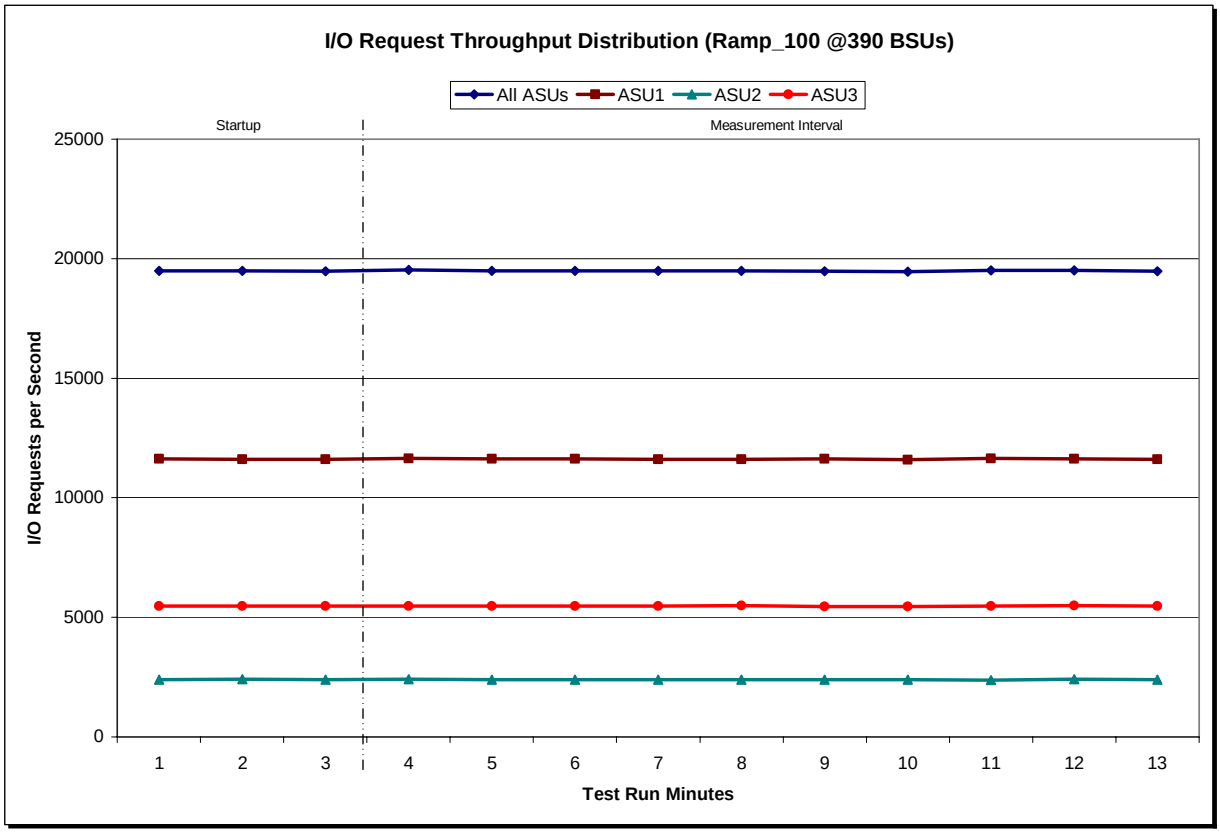
IOPS Test Results File

IOPS Test Run – I/O Request Throughput Distribution Data

390 BSUs	Start	Stop	Interval	Duration
Start-Up/Ramp-Up	13:57:43	14:00:44	0-2	0:03:01
Measurement Interval	14:00:44	14:10:44	3-12	0:10:00

60 second intervals	All ASUs	ASU1	ASU2	ASU3
0	19,499.90	11,626.85	2,400.63	5,472.42
1	19,491.07	11,610.40	2,406.10	5,474.57
2	19,481.63	11,614.87	2,401.35	5,465.42
3	19,532.75	11,653.27	2,403.72	5,475.77
4	19,498.65	11,625.40	2,396.32	5,476.93
5	19,498.68	11,626.22	2,393.95	5,478.52
6	19,484.20	11,613.50	2,399.03	5,471.67
7	19,484.58	11,611.67	2,389.97	5,482.95
8	19,479.68	11,626.72	2,395.35	5,457.62
9	19,454.77	11,592.78	2,401.03	5,460.95
10	19,506.85	11,648.05	2,382.50	5,476.30
11	19,513.63	11,626.73	2,404.78	5,482.12
12	19,474.78	11,601.33	2,393.10	5,480.35
Average	19,492.86	11,622.57	2,395.98	5,474.32

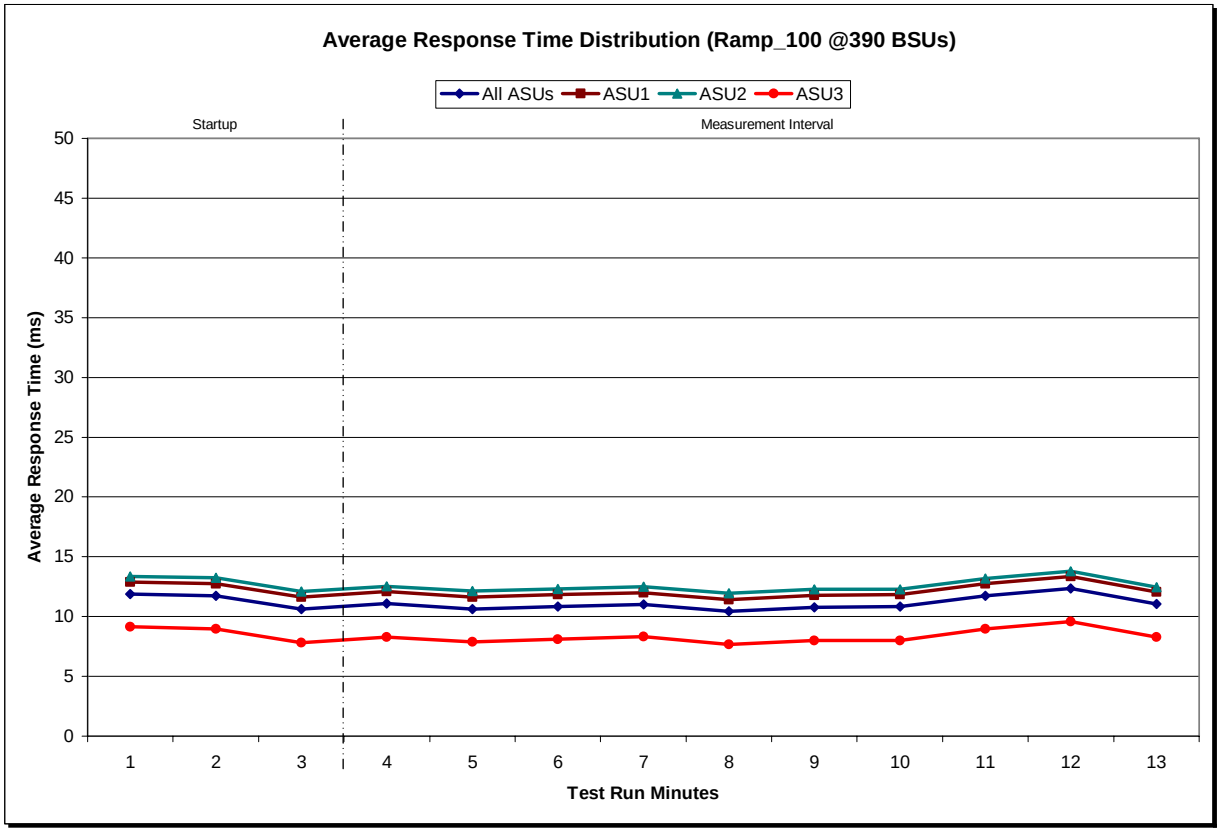
IOPS Test Run – I/O Request Throughput Distribution Graph



IOPS Test Run – Average Response Time (ms) Distribution Data

390 BSUs	Start	Stop	Interval	Duration
Start-Up/Ramp-Up	13:57:43	14:00:44	0-2	0:03:01
Measurement Interval	14:00:44	14:10:44	3-12	0:10:00
60 second intervals	**All ASUs**	**ASU1**	**ASU2**	**ASU3**
0	11.89	12.89	13.37	9.13
1	11.75	12.76	13.24	8.96
2	10.61	11.62	12.10	7.82
3	11.08	12.10	12.52	8.27
4	10.63	11.63	12.13	7.87
5	10.85	11.84	12.32	8.10
6	11.02	11.99	12.47	8.31
7	10.43	11.43	11.95	7.66
8	10.78	11.78	12.27	7.99
9	10.82	11.85	12.27	8.01
10	11.74	12.75	13.18	8.97
11	12.35	13.37	13.78	9.57
12	11.03	12.04	12.46	8.27
Average	11.07	12.08	12.54	8.30

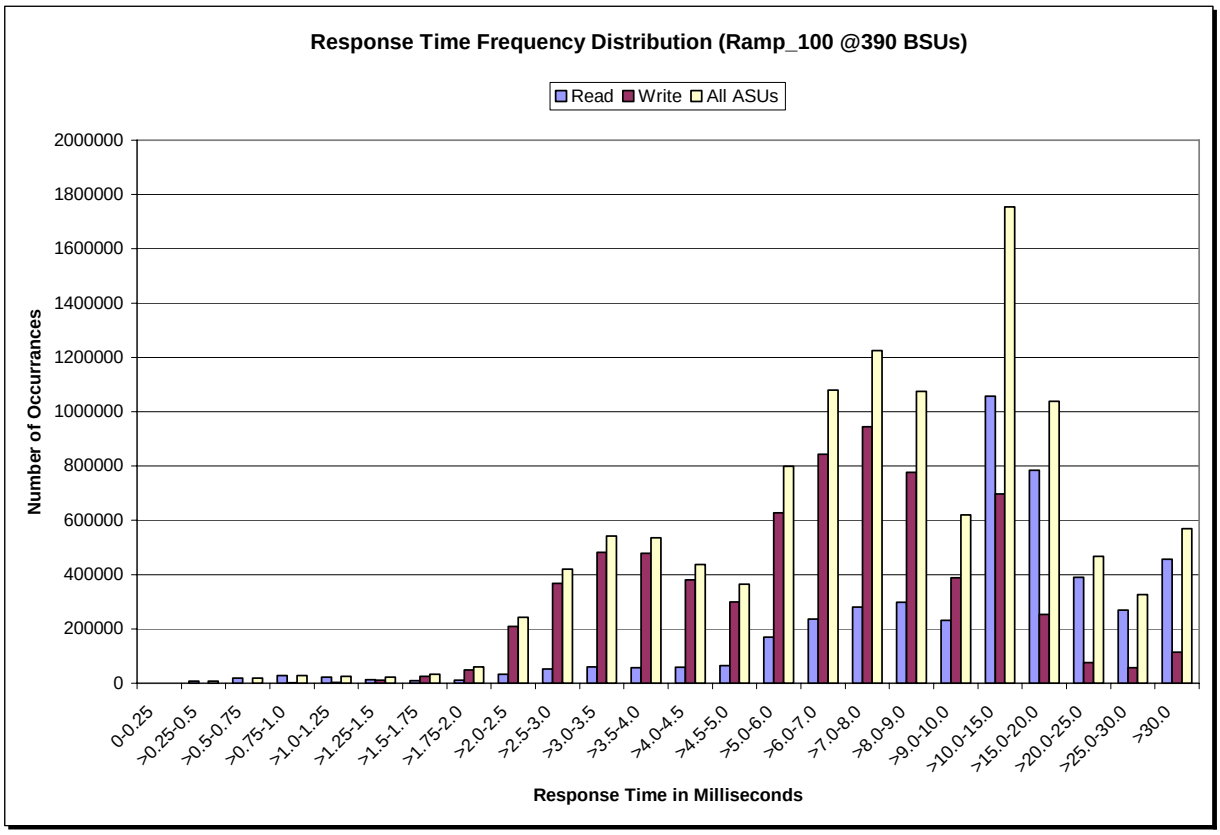
IOPS Test Run – Average Response Time (ms) Distribution Graph



IOPS Test Run – Response Time Frequency Distribution Data

Response Time (ms)	0-0.25	>0.25-0.5	>0.5-0.75	>0.75-1.0	>1.0-1.25	>1.25-1.5	>1.5-1.75	>1.75-2.0
Read	434	8,239	19,179	28,012	22,299	12,062	8,828	10,650
Write	0	118	283	946	3,568	10,650	25,014	49,247
All ASUs	434	8,357	19,462	28,958	25,867	22,712	33,842	59,897
ASU1	368	7,023	16,269	24,058	20,550	14,981	18,387	30,642
ASU2	66	1,293	3,083	4,480	3,795	3,094	4,583	7,815
ASU3	0	41	110	420	1,522	4,637	10,872	21,440
Response Time (ms)	**>2.0-2.5**	**>2.5-3.0**	**>3.0-3.5**	**>3.5-4.0**	**>4.0-4.5**	**>4.5-5.0**	**>5.0-6.0**	**>6.0-7.0**
Read	33,511	52,789	60,030	57,588	58,280	65,080	170,159	235,980
Write	208,464	367,666	481,199	478,676	379,609	300,108	628,320	843,010
All ASUs	241,975	420,455	541,229	536,264	437,889	365,188	798,479	1,078,990
ASU1	118,770	203,505	259,101	254,064	210,165	180,763	413,471	567,229
ASU2	31,198	53,657	67,158	63,552	50,436	41,765	91,801	124,807
ASU3	92,007	163,293	214,970	218,648	177,288	142,660	293,207	386,954
Response Time (ms)	**>7.0-8.0**	**>8.0-9.0**	**>9.0-10.0**	**>10.0-15.0**	**>15.0-20.0**	**>20.0-25.0**	**>25.0-30.0**	**>30.0**
Read	281,282	298,145	231,961	1,057,221	784,797	390,592	269,504	455,787
Write	944,245	776,658	387,561	697,692	252,911	76,548	57,043	113,568
All ASUs	1,225,527	1,074,803	619,522	1,754,913	1,037,708	467,140	326,547	569,355
ASU1	650,330	592,969	370,446	1,232,862	786,955	366,388	246,527	387,585
ASU2	141,173	122,512	71,009	199,304	128,319	62,932	48,552	111,186
ASU3	434,024	359,322	178,067	322,747	122,434	37,820	31,468	70,584

IOPS Test Run –Response Time Frequency Distribution Graph



IOPS Test Run – I/O Request Information

I/O Requests Completed in the Measurement Interval	I/O Requests Completed with Response Time = or < 30 ms	I/O Requests Completed with Response Time > 30 ms
11,695,513	11,126,158	569,355

IOPS Test Run – Measured Intensity Multiplier and Coefficient of Variation

Clause 3.4.3

IM – Intensity Multiplier: *The ratio of I/Os for each I/O stream relative to the total I/Os for all I/O streams (ASU1-1 – ASU3-1) as required by the benchmark specification.*

Clauses 5.1.10 and 5.3.13.2

MIM – Measured Intensity Multiplier: *The Measured Intensity Multiplier represents the ratio of measured I/Os for each I/O stream relative to the total I/Os measured for all I/O streams (ASU1-1 – ASU3-1). This value may differ from the corresponding Expected Intensity Multiplier by no more than 5%.*

Clause 5.3.13.3

COV – Coefficient of Variation: *This measure of variation for the Measured Intensity Multiplier cannot exceed 0.2.*

	ASU1-1	ASU1-2	ASU1-3	ASU1-4	ASU2-1	ASU2-2	ASU2-3	ASU3-1
IM	***0.0350***	***0.2810***	***0.0700***	***0.2100***	***0.0180***	***0.0700***	***0.0350***	***0.2810***
MIM	0.0351	0.2810	0.0699	0.2101	0.0180	0.0699	0.0350	0.2808
COV	0.006	0.001	0.002	0.001	0.009	0.004	0.004	0.001

Primary Metrics Test – Response Time Ramp Test Phase

Clause 5.4.4.3

The Response Time Ramp Test Phase consists of five Test Runs, one each at 95%, 90%, 80%, 50%, and 10% of the load point (100%) used to generate the SPC-1 IOPS™ primary metric. Each of the five Test Runs has a Measurement Interval of ten (10) minutes. The Response Time Ramp Test Phase immediately follows the IOPS Test Phase without any interruption or manual intervention.

The five Response Time Ramp Test Runs, in conjunction with the IOPS Test Run (100%), demonstrate the relationship between Average Response Time and I/O Request Throughput for the Tested Storage Configuration (TSC) as illustrated in the response time/throughput curve on page 13.

In addition, the Average Response Time measured during the 10% Test Run is the value for the SPC-1 LRT™ metric. That value represents the Average Response Time of a lightly loaded TSC.

Clause 9.4.3.7.3

The following content shall appear in the FDR for the Response Time Ramp Phase:

1. *A Response Time Ramp Distribution.*
2. *The human readable Test Run Results File produced by the Workload Generator for each Test Run within the Response Time Ramp Test Phase.*
3. *For the 10% Load Level Test Run (SPC-1 LRT™ metric) an Average Response Time Distribution.*
4. *A listing or screen image of all input parameters supplied to the Workload Generator.*

SPC-1 Workload Generator Input Parameters

The SPC-1 Workload Generator input parameters for the Sustainability, IOPS, Response Time Ramp, Repeatability, and Persistence Test Runs are documented in "Appendix E: SPC-1 Workload Generator Input Parameters" on Page 97.

Response Time Ramp Test Results File

A link to each test result file generated from each Response Time Ramp Test Run list listed below.

95% Load Level

90% Load Level

80% Load Level

50% Load Level

10% Load Level

Response Time Ramp Distribution (IOPS) Data

The five Test Runs that comprise the Response Time Ramp Phase are executed at 95%, 90%, 80%, 50%, and 10% of the Business Scaling Unit (BSU) load level used to produce the SPC-1 IOPS™ primary metric. The 100% BSU load level is included in the following Response Time Ramp data tables and graphs for completeness.

100% Load Level - 390 BSUs	Start	Stop	Interval	Duration
Start-Up/Ramp-Up	13:57:43	14:00:44	0-2	0:03:01
Measurement Interval	14:00:44	14:10:44	3-12	0:10:00

(60 second intervals)	All ASUs	ASU-1	ASU-2	ASU-3
0	19,499.90	11,626.85	2,400.63	5,472.42
1	19,491.07	11,610.40	2,406.10	5,474.57
2	19,481.63	11,614.87	2,401.35	5,465.42
3	19,532.75	11,653.27	2,403.72	5,475.77
4	19,498.65	11,625.40	2,396.32	5,476.93
5	19,498.68	11,626.22	2,393.95	5,478.52
6	19,484.20	11,613.50	2,399.03	5,471.67
7	19,484.58	11,611.67	2,389.97	5,482.95
8	19,479.68	11,626.72	2,395.35	5,457.62
9	19,454.77	11,592.78	2,401.03	5,460.95
10	19,506.85	11,648.05	2,382.50	5,476.30
11	19,513.63	11,626.73	2,404.78	5,482.12
12	19,474.78	11,601.33	2,393.10	5,480.35
Average	19,492.86	11,622.57	2,395.98	5,474.32

95% Load Level - 370 BSUs	Start	Stop	Interval	Duration
Start-Up/Ramp-Up	14:10:50	14:13:51	0-2	0:03:01
Measurement Interval	14:13:51	14:23:51	3-12	0:10:00

(60 second intervals)	All ASUs	ASU-1	ASU-2	ASU-3
0	18,507.28	11,033.83	2,271.92	5,201.53
1	18,498.25	11,004.65	2,283.03	5,210.57
2	18,492.62	11,043.78	2,264.50	5,184.33
3	18,506.97	11,015.85	2,281.43	5,209.68
4	18,479.23	11,021.87	2,272.40	5,184.97
5	18,517.87	11,044.53	2,275.05	5,198.28
6	18,496.60	11,039.02	2,272.15	5,185.43
7	18,516.45	11,034.03	2,273.15	5,209.27
8	18,520.18	11,032.38	2,275.32	5,212.48
9	18,488.22	11,021.22	2,273.50	5,193.50
10	18,511.62	11,049.03	2,267.03	5,195.55
11	18,482.03	11,004.95	2,269.98	5,207.10
12	18,492.22	11,017.40	2,271.42	5,203.40
Average	18,501.14	11,028.03	2,273.14	5,199.97

90% Load Level - 351 BSUs	Start	Stop	Interval	Duration
Start-Up/Ramp-Up	14:23:57	14:26:58	0-2	0:03:01
Measurement Interval	14:26:58	14:36:58	3-12	0:10:00

(60 second intervals)	All ASUs	ASU-1	ASU-2	ASU-3
0	17,542.67	10,453.67	2,158.78	4,930.22
1	17,538.07	10,460.65	2,153.60	4,923.82
2	17,526.63	10,450.22	2,158.20	4,918.22
3	17,526.18	10,449.07	2,154.10	4,923.02
4	17,549.02	10,453.63	2,164.20	4,931.18
5	17,529.08	10,444.30	2,153.68	4,931.10
6	17,564.25	10,462.48	2,155.12	4,946.65
7	17,545.07	10,454.30	2,159.40	4,931.37
8	17,526.67	10,446.67	2,160.38	4,919.62
9	17,573.93	10,481.60	2,162.18	4,930.15
10	17,543.38	10,458.68	2,163.47	4,921.23
11	17,553.83	10,468.85	2,148.92	4,936.07
12	17,580.60	10,482.17	2,161.23	4,937.20
Average	17,549.20	10,460.18	2,158.27	4,930.76

80% Load Level - 312 BSUs	Start	Stop	Interval	Duration
Start-Up/Ramp-Up	14:37:04	14:40:05	0-2	0:03:01
Measurement Interval	14:40:05	14:50:05	3-12	0:10:00

(60 second intervals)	All ASUs	ASU-1	ASU-2	ASU-3
0	15,585.47	9,279.35	1,914.08	4,392.03
1	15,597.95	9,296.20	1,918.33	4,383.42
2	15,609.58	9,304.53	1,925.22	4,379.83
3	15,598.20	9,304.08	1,914.75	4,379.37
4	15,621.82	9,308.68	1,930.60	4,382.53
5	15,606.40	9,294.30	1,923.78	4,388.32
6	15,598.47	9,291.43	1,916.50	4,390.53
7	15,597.90	9,292.67	1,918.13	4,387.10
8	15,609.75	9,293.20	1,925.33	4,391.22
9	15,621.80	9,312.02	1,922.03	4,387.75
10	15,584.67	9,294.75	1,909.23	4,380.68
11	15,600.97	9,304.28	1,918.92	4,377.77
12	15,617.20	9,316.23	1,917.58	4,383.38
Average	15,605.72	9,301.17	1,919.69	4,384.87

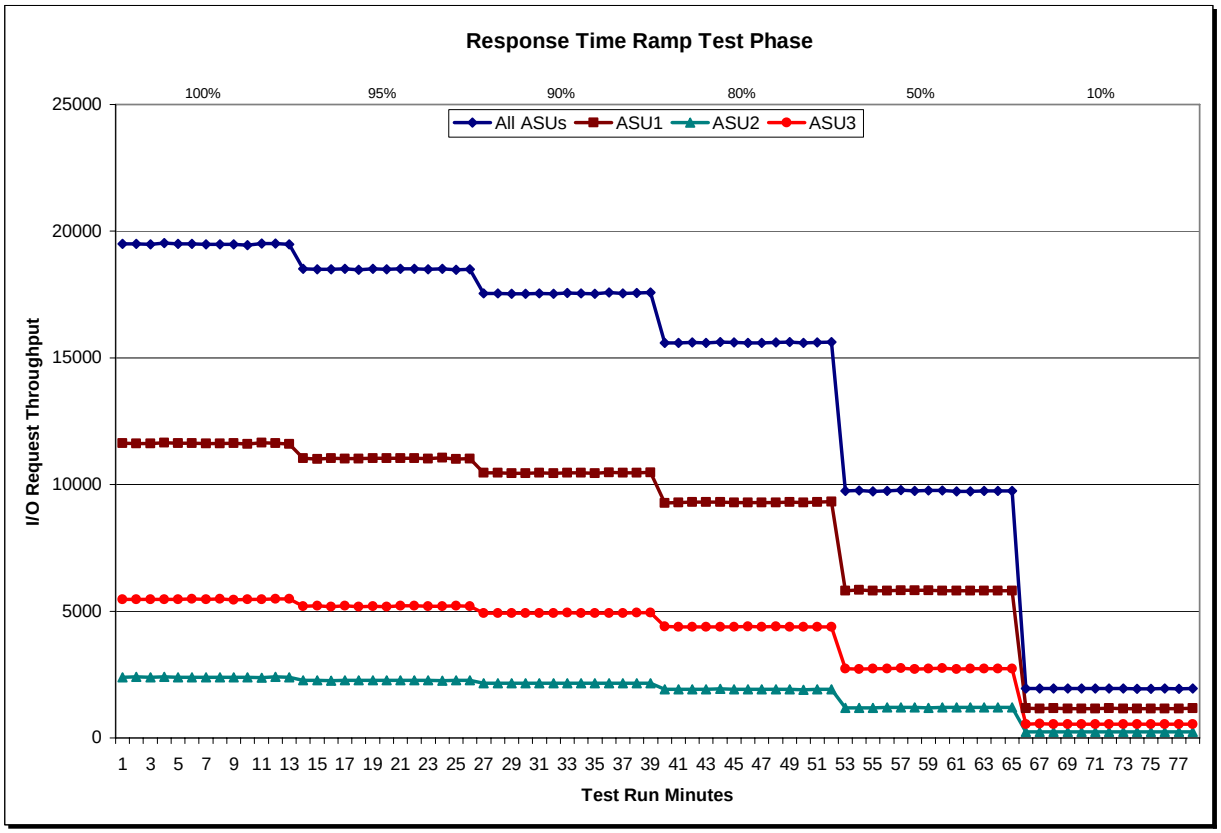
50% Load Level - 195 BSUs	Start	Stop	Interval	Duration
Start-Up/Ramp-Up	14:50:11	14:53:12	0-2	0:03:01
Measurement Interval	14:53:12	15:03:12	3-12	0:10:00

(60 second intervals)	All ASUs	ASU-1	ASU-2	ASU-3
0	9,740.22	5,815.25	1,190.88	2,734.08
1	9,757.92	5,835.18	1,197.27	2,725.47
2	9,738.88	5,803.20	1,196.70	2,738.98
3	9,745.77	5,811.37	1,203.67	2,730.73
4	9,775.57	5,823.45	1,201.45	2,750.67
5	9,748.42	5,827.12	1,198.73	2,722.57
6	9,759.03	5,823.92	1,193.70	2,741.42
7	9,762.18	5,809.12	1,203.85	2,749.22
8	9,738.02	5,809.55	1,203.40	2,725.07
9	9,725.12	5,800.22	1,197.45	2,727.45
10	9,743.27	5,803.90	1,198.75	2,740.62
11	9,742.25	5,805.05	1,198.28	2,738.92
12	9,740.97	5,805.02	1,203.52	2,732.43
Average	9,748.06	5,811.87	1,200.28	2,735.91

10% Load Level - 39 BSUs	Start	Stop	Interval	Duration
Start-Up/Ramp-Up	15:03:18	15:06:19	0-2	0:03:01
Measurement Interval	15:06:19	15:16:19	3-12	0:10:00

(60 second intervals)	All ASUs	ASU-1	ASU-2	ASU-3
0	1,949.68	1,165.68	240.38	543.62
1	1,953.90	1,159.08	241.73	553.08
2	1,945.70	1,165.45	236.85	543.40
3	1,945.12	1,156.42	239.67	549.03
4	1,948.75	1,159.78	239.72	549.25
5	1,951.35	1,163.32	240.30	547.73
6	1,952.20	1,165.10	241.42	545.68
7	1,946.43	1,159.97	238.22	548.25
8	1,943.43	1,159.70	237.20	546.53
9	1,939.07	1,155.47	235.77	547.83
10	1,948.23	1,162.32	238.85	547.07
11	1,939.62	1,161.67	236.23	541.72
12	1,946.50	1,165.17	239.12	542.22
Average	1,946.07	1,160.89	238.65	546.53

Response Time Ramp Distribution (IOPS) Graph

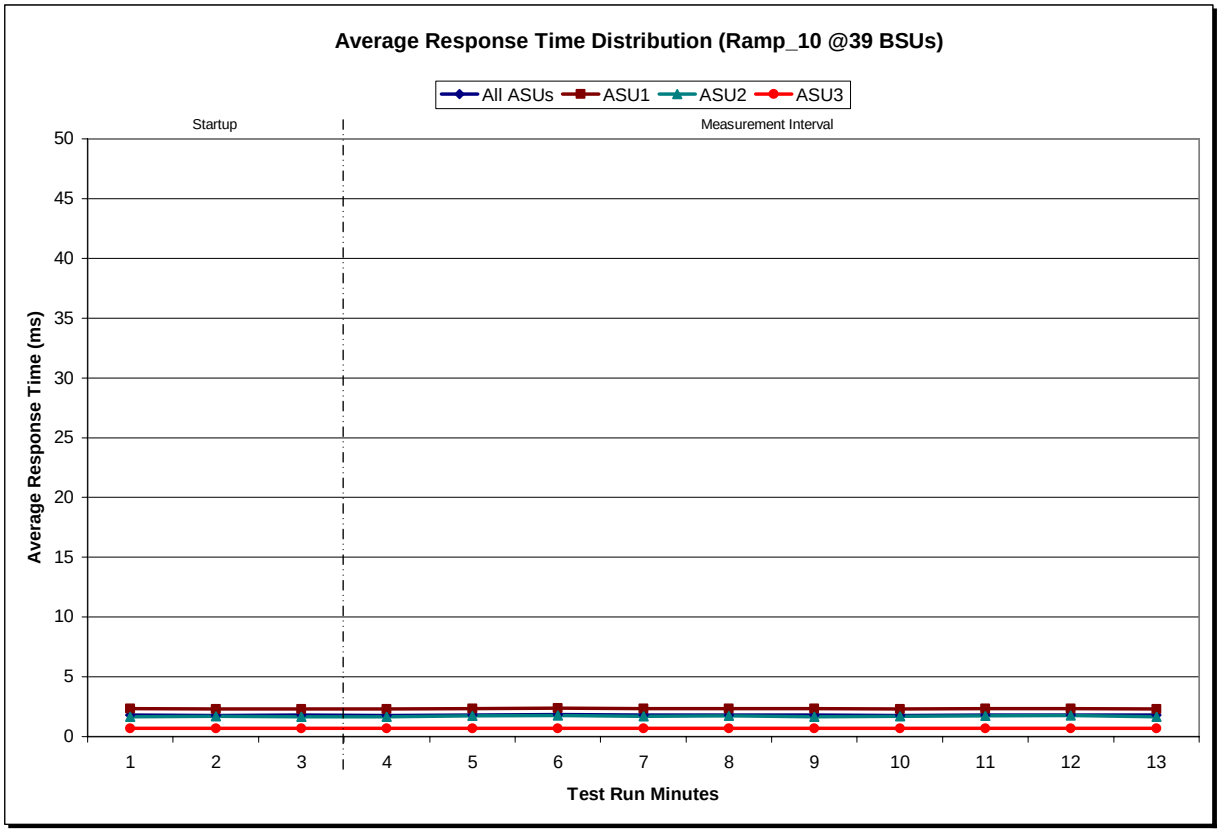


SPC-1 LRT™ Average Response Time (ms) Distribution Data

39 BSUs	Start	Stop	Interval	Duration
Start-Up/Ramp-Up	15:03:18	15:06:19	0-2	0:03:01
Measurement Interval	15:06:19	15:16:19	3-12	0:10:00

60 second intervals	All ASUs	ASU1	ASU2	ASU3
0	1.78	2.32	1.65	0.69
1	1.78	2.32	1.68	0.68
2	1.78	2.32	1.67	0.68
3	1.77	2.31	1.67	0.69
4	1.79	2.33	1.71	0.68
5	1.82	2.38	1.75	0.68
6	1.79	2.33	1.70	0.68
7	1.80	2.34	1.74	0.68
8	1.80	2.35	1.67	0.68
9	1.78	2.32	1.70	0.68
10	1.81	2.35	1.74	0.68
11	1.80	2.34	1.76	0.68
12	1.78	2.32	1.66	0.69
Average	1.79	2.34	1.71	0.68

SPC-1 LRT™ Average Response Time (ms) Distribution Graph



SPC-1 LRT™ (10%) – Measured Intensity Multiplier and Coefficient of Variation

Clause 3.4.3

IM – Intensity Multiplier: *The ratio of I/Os for each I/O stream relative to the total I/Os for all I/O streams (ASU1-1 – ASU3-1) as required by the benchmark specification.*

Clauses 5.1.10 and 5.3.13.2

MIM – Measured Intensity Multiplier: *The Measured Intensity Multiplier represents the ratio of measured I/Os for each I/O stream relative to the total I/Os measured for all I/O streams (ASU1-1 – ASU3-1). This value may differ from the corresponding Expected Intensity Multiplier by no more than 5%.*

Clause 5.3.13.3

COV – Coefficient of Variation: *This measure of variation for the Measured Intensity Multiplier cannot exceed 0.2.*

	ASU1-1	ASU1-2	ASU1-3	ASU1-4	ASU2-1	ASU2-2	ASU2-3	ASU3-1
IM	***0.0350***	***0.2810***	***0.0700***	***0.2100***	***0.0180***	***0.0700***	***0.0350***	***0.2810***
MIM	0.0349	0.2809	0.0701	0.2106	0.0178	0.0699	0.0349	0.2808
COV	0.010	0.004	0.012	0.006	0.019	0.008	0.019	0.005

Repeatability Test

Clause 5.4.5

The Repeatability Test demonstrates the repeatability and reproducibility of the SPC-1 IOPS™ primary metric and SPC-1 LRT™ metric generated in earlier Test Runs.

There are two identical Repeatability Test Phases. Each Test Phase contains two Test Runs. Each of the Test Runs will have a Measurement Interval of no less than ten (10) minutes. The two Test Runs in each Test Phase will be executed without interruption or any type of manual intervention.

The first Test Run in each Test Phase is executed at the 10% load point. The Average Response Time from each of the Test Runs is compared to the SPC-1 LRT™ metric. Each Average Response Time value must be less than the SPC-1 LRT™ metric plus 5% or less than the SPC-1 LRT™ metric plus one (1) millisecond (ms).

The second Test Run in each Test Phase is executed at the 100% load point. The I/O Request Throughput from the Test Runs is compared to the SPC-1 IOPS™ primary metric. Each I/O Request Throughput value must be greater than the SPC-1 IOPS™ primary metric minus 5%. In addition, the Average Response Time for each Test Run cannot exceed 30 milliseconds.

If any of the above constraints are not met, the benchmark measurement is invalid.

Clause 9.4.3.7.4

The following content shall appear in the FDR for each Test Run in the two Repeatability Test Phases:

1. *A table containing the results of the Repeatability Test.*
2. *An I/O Request Throughput Distribution graph and table.*
3. *An Average Response Time Distribution graph and table.*
4. *The human readable Test Run Results File produced by the Workload Generator.*
5. *A listing or screen image of all input parameters supplied to the Workload Generator.*

SPC-1 Workload Generator Input Parameters

The SPC-1 Workload Generator input parameters for the Sustainability, IOPS, Response Time Ramp, Repeatability, and Persistence Test Runs are documented in "Appendix E: SPC-1 Workload Generator Input Parameters" on Page 97.

Repeatability Test Results File

The values for the SPC-1 IOPS™, SPC-1 LRT™, and the Repeatability Test measurements are listed in the tables below.

	SPC-1 IOPS™
Primary Metrics	***19,492.86***
Repeatability Test Phase 1	19,499.91
Repeatability Test Phase 2	19,511.21

The SPC-1 IOPS™ values in the above table were generated using 100% of the specified Business Scaling Unit (BSU) load level. Each of the Repeatability Test Phase values for SPC-1 IOPS™ must greater than 95% of the reported SPC-1 IOPS™ Primary Metric.

	SPC-1 LRT™
Primary Metrics	***1.79 ms***
Repeatability Test Phase 1	1.78 ms
Repeatability Test Phase 2	1.82 ms

The average response time values in the SPC-1 LRT™ column were generated using 10% of the specified Business Scaling Unit (BSU) load level. Each of the Repeatability Test Phase values for SPC-1 LRT™ must be less than 105% of the reported SPC-1 LRT™ Primary Metric or less than the reported SPC-1 LRT™ Primary Metric minus one (1) millisecond (ms)..

A link to the test result file generated from each Repeatability Test Run is listed below.

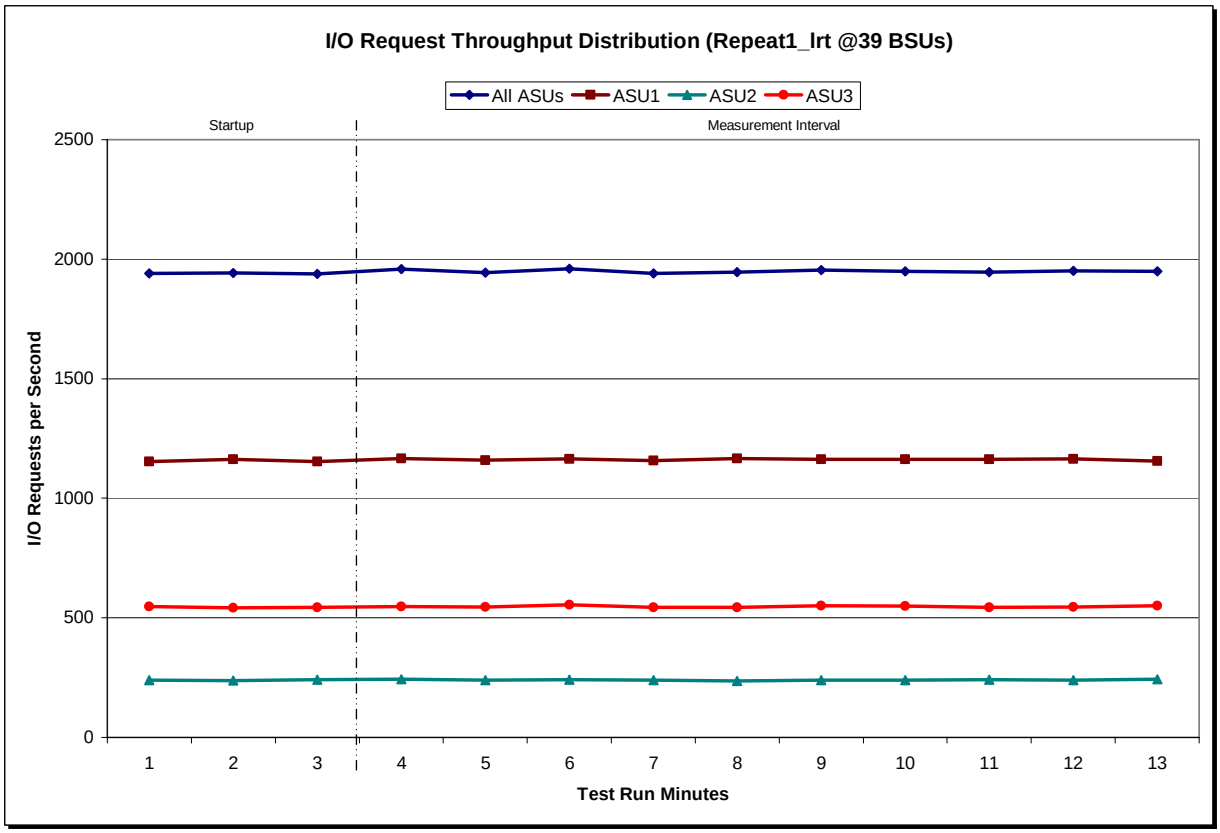
Repeatability Test Phase 1, Test Run 1 (LRT)
Repeatability Test Phase 1, Test Run 2 (IOPS)
Repeatability Test Phase 2, Test Run 1 (LRT)
Repeatability Test Phase 2, Test Run 2 (IOPS)

Repeatability 1 LRT – I/O Request Throughput Distribution Data

39 BSUs	Start	Stop	Interval	Duration
Start-Up/Ramp-Up	15:16:33	15:19:33	0-2	0:03:00
Measurement Interval	15:19:33	15:29:33	3-12	0:10:00

60 second intervals	All ASUs	ASU1	ASU2	ASU3
0	1,939.62	1,153.88	238.68	547.05
1	1,942.18	1,163.10	236.83	542.25
2	1,938.88	1,154.55	240.42	543.92
3	1,958.00	1,167.07	243.18	547.75
4	1,944.32	1,158.88	239.48	545.95
5	1,959.32	1,164.65	240.35	554.32
6	1,940.23	1,157.98	238.58	543.67
7	1,945.37	1,165.52	235.68	544.17
8	1,954.70	1,163.27	240.23	551.20
9	1,949.35	1,162.22	238.58	548.55
10	1,946.32	1,162.12	240.38	543.82
11	1,951.03	1,164.93	240.22	545.88
12	1,950.13	1,156.35	243.67	550.12
Average	1,949.88	1,162.30	240.04	547.54

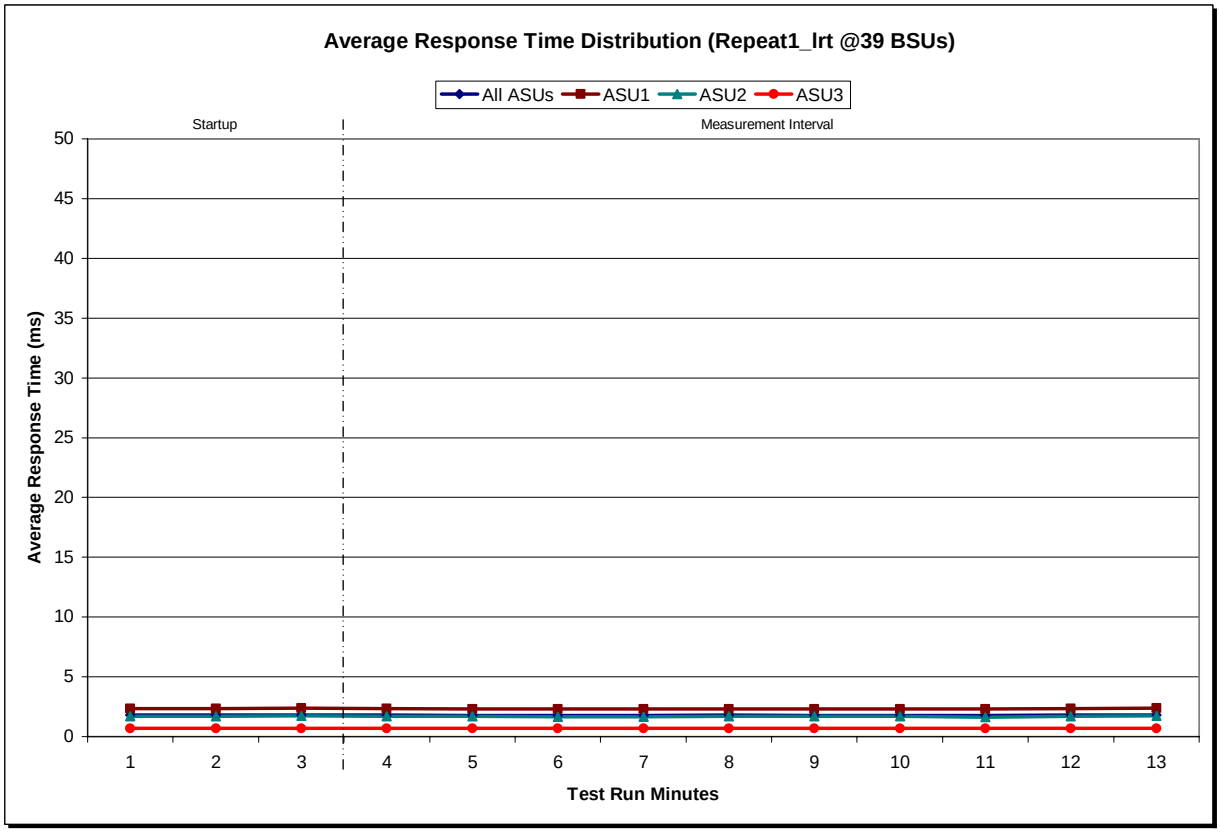
Repeatability 1 LRT – I/O Request Throughput Distribution Graph



Repeatability 1 LRT –Average Response Time (ms) Distribution Data

39 BSUs	Start	Stop	Interval	Duration
Start-Up/Ramp-Up	15:16:33	15:19:33	0-2	0:03:00
Measurement Interval	15:19:33	15:29:33	3-12	0:10:00
60 second intervals	**All ASUs**	**ASU1**	**ASU2**	**ASU3**
0	1.79	2.34	1.70	0.67
1	1.80	2.34	1.69	0.68
2	1.81	2.36	1.72	0.67
3	1.79	2.33	1.68	0.68
4	1.77	2.31	1.68	0.68
5	1.77	2.32	1.65	0.68
6	1.77	2.31	1.67	0.68
7	1.78	2.32	1.69	0.68
8	1.76	2.29	1.70	0.68
9	1.76	2.29	1.69	0.68
10	1.77	2.31	1.63	0.68
11	1.80	2.34	1.69	0.68
12	1.81	2.36	1.72	0.68
Average	1.78	2.32	1.68	0.68

Repeatability 1 LRT –Average Response Time (ms) Distribution Graph

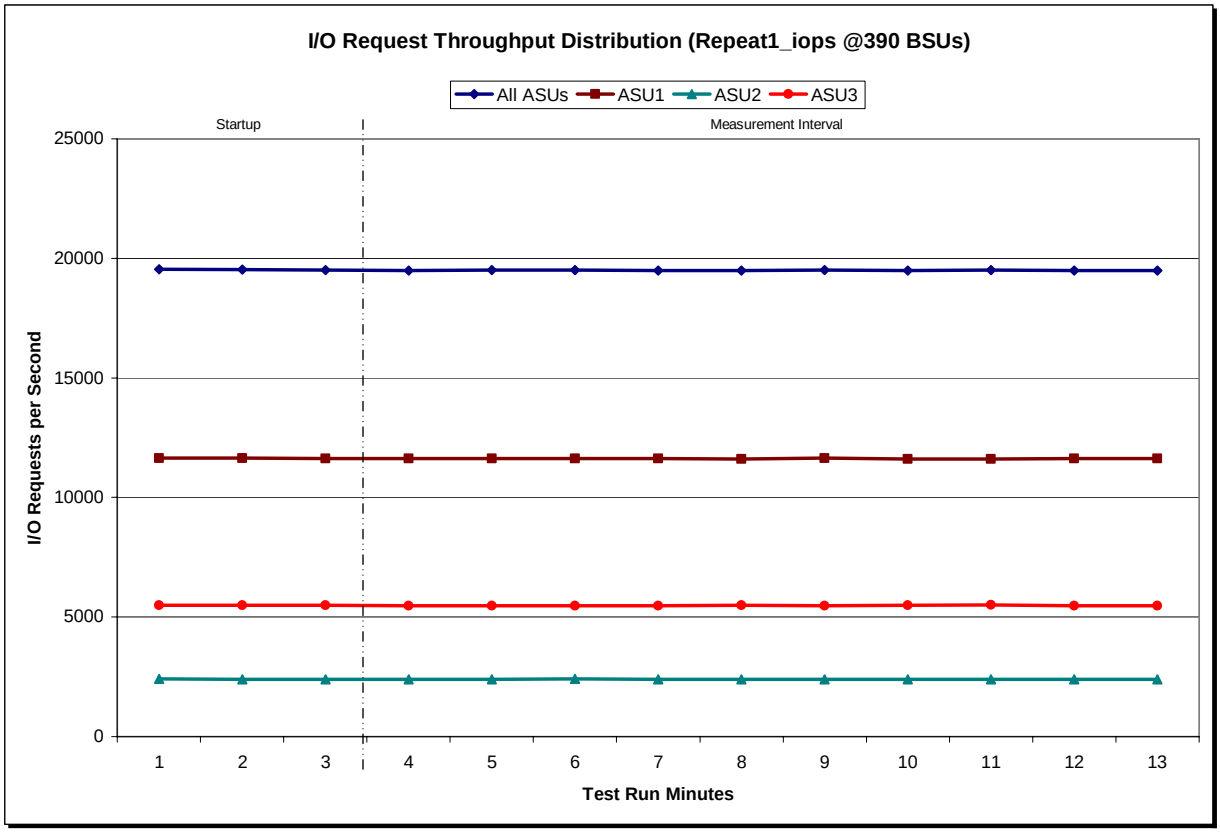


Repeatability 1 IOPS – I/O Request Throughput Distribution Data

390 BSUs	Start	Stop	Interval	Duration
Start-Up/Ramp-Up	15:29:39	15:32:40	0-2	0:03:01
Measurement Interval	15:32:40	15:42:40	3-12	0:10:00

60 second intervals	All ASUs	ASU1	ASU2	ASU3
0	19,549.18	11,645.50	2,405.87	5,497.82
1	19,519.78	11,638.20	2,394.25	5,487.33
2	19,514.12	11,628.80	2,398.83	5,486.48
3	19,498.48	11,627.58	2,396.52	5,474.38
4	19,506.85	11,631.67	2,396.07	5,479.12
5	19,505.08	11,631.45	2,404.12	5,469.52
6	19,494.45	11,630.92	2,391.33	5,472.20
7	19,500.33	11,618.02	2,397.52	5,484.80
8	19,510.82	11,639.85	2,400.38	5,470.58
9	19,491.68	11,612.42	2,395.27	5,484.00
10	19,502.42	11,607.10	2,392.23	5,503.08
11	19,495.22	11,623.02	2,394.65	5,477.55
12	19,493.75	11,634.22	2,395.65	5,463.88
Average	19,499.91	11,625.62	2,396.37	5,477.91

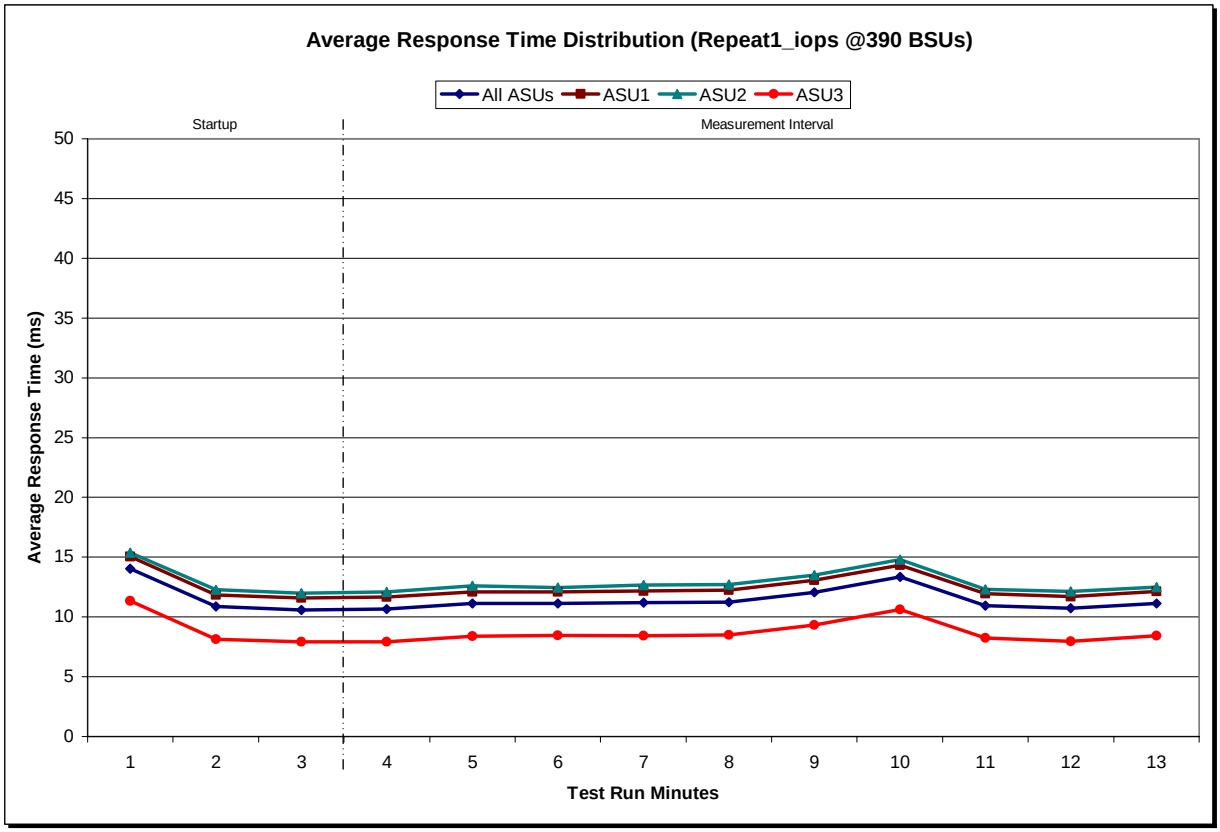
Repeatability 1 IOPS – I/O Request Throughput Distribution Graph



Repeatability 1 IOPS –Average Response Time (ms) Distribution Data

390 BSUs	Start	Stop	Interval	Duration
Start-Up/Ramp-Up	15:29:39	15:32:40	0-2	0:03:01
Measurement Interval	15:32:40	15:42:40	3-12	0:10:00
60 second intervals	**All ASUs**	**ASU1**	**ASU2**	**ASU3**
0	14.04	15.04	15.38	11.34
1	10.86	11.85	12.27	8.13
2	10.60	11.58	11.97	7.91
3	10.66	11.67	12.08	7.91
4	11.12	12.10	12.59	8.38
5	11.12	12.11	12.45	8.45
6	11.19	12.18	12.67	8.43
7	11.23	12.22	12.70	8.49
8	12.07	13.06	13.50	9.33
9	13.34	14.34	14.79	10.60
10	10.96	11.97	12.32	8.25
11	10.71	11.71	12.14	7.97
12	11.13	12.12	12.49	8.41
Average	11.35	12.35	12.77	8.62

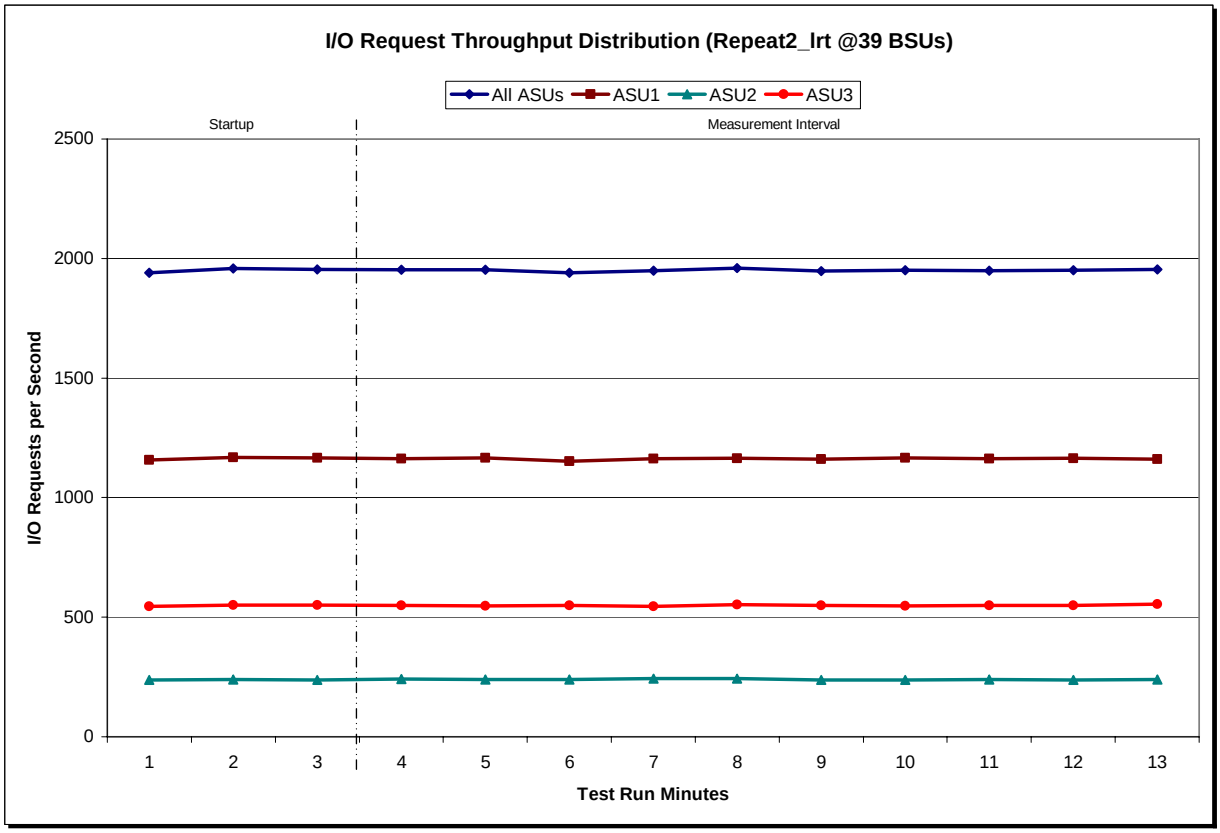
Repeatability 1 IOPS –Average Response Time (ms) Distribution Graph



Repeatability 2 LRT – I/O Request Throughput Distribution Data

39 BSUs	Start	Stop	Interval	Duration
Start-Up/Ramp-Up	15:42:53	15:45:53	0-2	0:03:00
Measurement Interval	15:45:53	15:55:53	3-12	0:10:00
60 second intervals	**All ASUs**	**ASU1**	**ASU2**	**ASU3**
0	1,940.47	1,156.48	238.32	545.67
1	1,958.35	1,167.25	239.95	551.15
2	1,954.87	1,166.63	237.98	550.25
3	1,952.23	1,162.17	241.88	548.18
4	1,952.72	1,165.90	238.80	548.02
5	1,939.78	1,152.08	239.63	548.07
6	1,950.12	1,162.53	242.13	545.45
7	1,959.87	1,164.45	242.67	552.75
8	1,947.98	1,161.30	237.98	548.70
9	1,950.67	1,166.12	237.13	547.42
10	1,949.95	1,162.07	239.25	548.63
11	1,950.62	1,164.55	237.47	548.60
12	1,954.27	1,161.67	239.07	553.53
Average	1,950.82	1,162.28	239.60	548.94

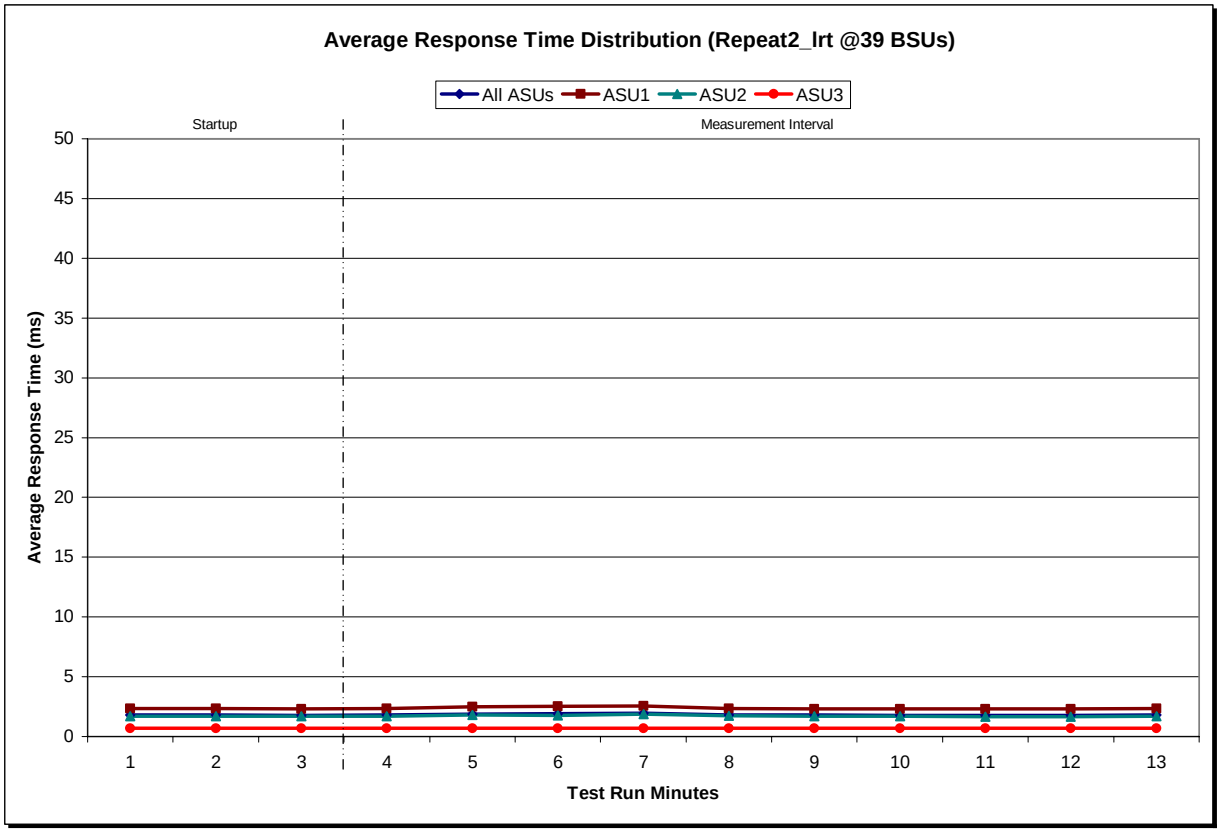
Repeatability 2 LRT – I/O Request Throughput Distribution Graph



Repeatability 2 LRT –Average Response Time (ms) Distribution Data

39 BSUs	Start	Stop	Interval	Duration
Start-Up/Ramp-Up	15:42:53	15:45:53	0-2	0:03:00
Measurement Interval	15:45:53	15:55:53	3-12	0:10:00
60 second intervals	**All ASUs**	**ASU1**	**ASU2**	**ASU3**
0	1.78	2.32	1.69	0.68
1	1.78	2.32	1.68	0.68
2	1.78	2.31	1.70	0.68
3	1.79	2.33	1.69	0.69
4	1.89	2.47	1.80	0.69
5	1.90	2.51	1.75	0.68
6	1.94	2.55	1.87	0.68
7	1.80	2.34	1.74	0.68
8	1.78	2.32	1.71	0.68
9	1.77	2.30	1.68	0.68
10	1.78	2.32	1.64	0.69
11	1.77	2.31	1.67	0.68
12	1.79	2.33	1.68	0.69
Average	1.82	2.38	1.72	0.68

Repeatability 2 LRT –Average Response Time (ms) Distribution Graph

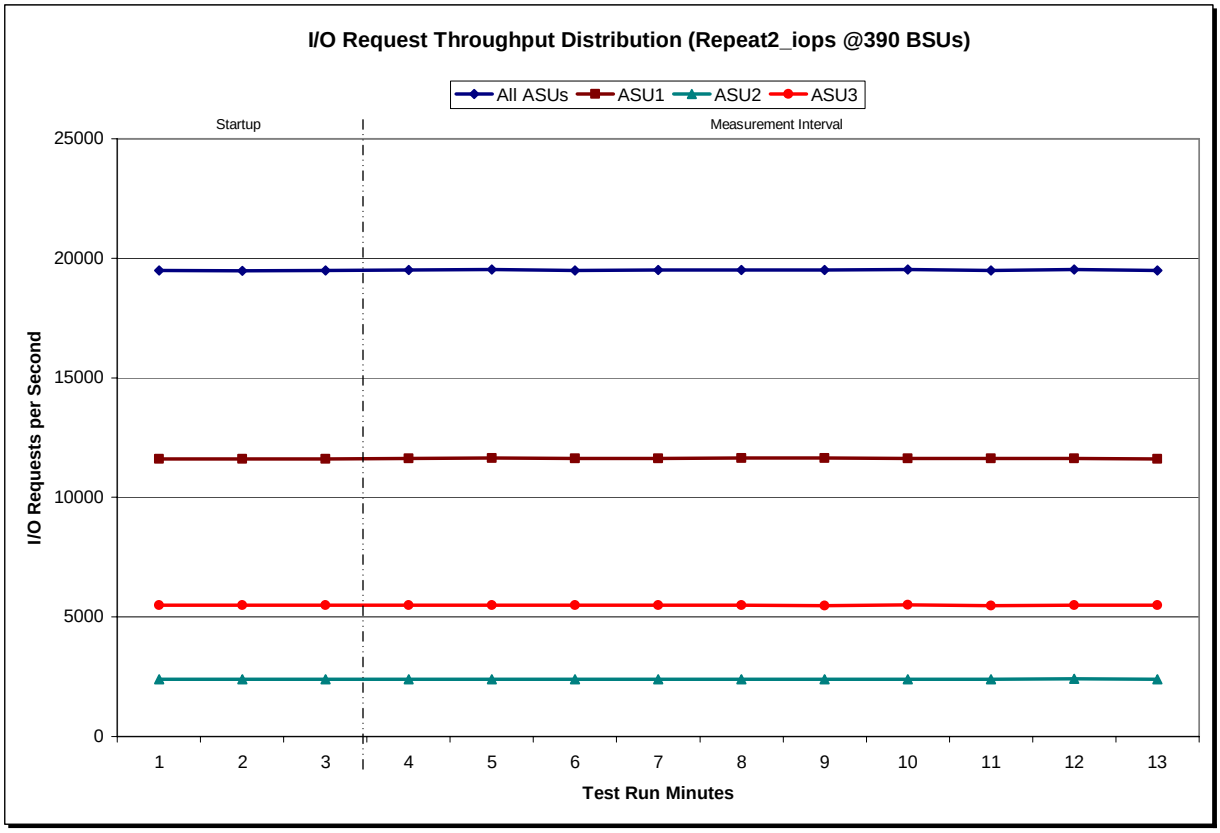


Repeatability 2 IOPS – I/O Request Throughput Distribution Data

390 BSUs	Start	Stop	Interval	Duration
Start-Up/Ramp-Up	15:55:59	15:59:00	0-2	0:03:01
Measurement Interval	15:59:00	16:09:00	3-12	0:10:00

60 second intervals	All ASUs	ASU1	ASU2	ASU3
0	19,484.60	11,605.22	2,395.52	5,483.87
1	19,474.28	11,605.45	2,385.95	5,482.88
2	19,488.15	11,609.43	2,395.98	5,482.73
3	19,503.23	11,622.42	2,394.58	5,486.23
4	19,531.62	11,642.87	2,400.70	5,488.05
5	19,499.28	11,619.87	2,398.63	5,480.78
6	19,513.83	11,628.97	2,394.27	5,490.60
7	19,515.02	11,644.60	2,389.27	5,481.15
8	19,515.85	11,638.97	2,402.50	5,474.38
9	19,521.02	11,623.72	2,392.57	5,504.73
10	19,493.43	11,624.88	2,399.68	5,468.87
11	19,521.32	11,630.80	2,404.47	5,486.05
12	19,497.53	11,615.33	2,391.78	5,490.42
Average	19,511.21	11,629.24	2,396.85	5,485.13

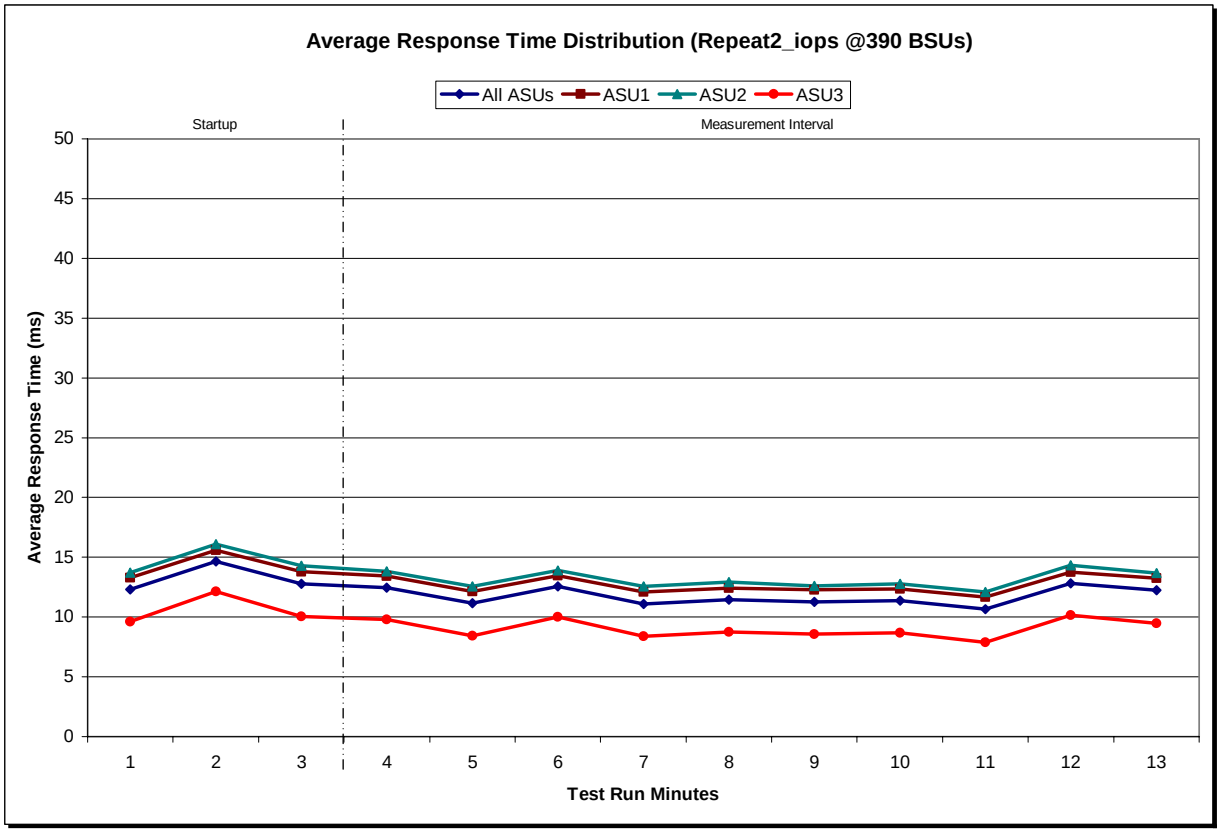
Repeatability 2 IOPS – I/O Request Throughput Distribution Graph



Repeatability 2 IOPS –Average Response Time (ms) Distribution Data

390 BSUs	Start	Stop	Interval	Duration
Start-Up/Ramp-Up	15:55:59	15:59:00	0-2	0:03:01
Measurement Interval	15:59:00	16:09:00	3-12	0:10:00
60 second intervals	**All ASUs**	**ASU1**	**ASU2**	**ASU3**
0	12.30	13.27	13.71	9.61
1	14.67	15.57	16.09	12.14
2	12.79	13.77	14.28	10.04
3	12.45	13.43	13.83	9.78
4	11.15	12.14	12.57	8.44
5	12.55	13.47	13.89	10.01
6	11.10	12.09	12.55	8.38
7	11.46	12.43	12.91	8.76
8	11.27	12.27	12.60	8.55
9	11.37	12.36	12.77	8.66
10	10.66	11.66	12.11	7.89
11	12.81	13.75	14.32	10.16
12	12.24	13.26	13.69	9.46
Average	11.71	12.69	13.12	9.01

Repeatability 2 IOPS –Average Response Time (ms) Distribution Graph



Repeatability 1 (LRT)
Measured Intensity Multiplier and Coefficient of Variation

Clause 3.4.3

IM – Intensity Multiplier: *The ratio of I/Os for each I/O stream relative to the total I/Os for all I/O streams (ASU1-1 – ASU3-1) as required by the benchmark specification.*

Clauses 5.1.10 and 5.3.13.2

MIM – Measured Intensity Multiplier: *The Measured Intensity Multiplier represents the ratio of measured I/Os for each I/O stream relative to the total I/Os measured for all I/O streams (ASU1-1 – ASU3-1). This value may differ from the corresponding Expected Intensity Multiplier by no more than 5%.*

Clause 5.3.13.3

COV – Coefficient of Variation: *This measure of variation for the Measured Intensity Multiplier cannot exceed 0.2.*

	ASU1-1	ASU1-2	ASU1-3	ASU1-4	ASU2-1	ASU2-2	ASU2-3	ASU3-1
IM	***0.0350***	***0.2810***	***0.0700***	***0.2100***	***0.0180***	***0.0700***	***0.0350***	***0.2810***
MIM	0.0352	0.2807	0.0704	0.2097	0.0182	0.0700	0.0349	0.2808
COV	0.018	0.004	0.006	0.006	0.018	0.009	0.015	0.004

Repeatability 1 (IOPS)
Measured Intensity Multiplier and Coefficient of Variation

	ASU1-1	ASU1-2	ASU1-3	ASU1-4	ASU2-1	ASU2-2	ASU2-3	ASU3-1
IM	***0.0350***	***0.2810***	***0.0700***	***0.2100***	***0.0180***	***0.0700***	***0.0350***	***0.2810***
MIM	0.0351	0.2811	0.0700	0.2100	0.0180	0.0700	0.0349	0.2809
COV	0.006	0.002	0.002	0.002	0.006	0.002	0.006	0.002

Repeatability 2 (LRT)
Measured Intensity Multiplier and Coefficient of Variation

	ASU1-1	ASU1-2	ASU1-3	ASU1-4	ASU2-1	ASU2-2	ASU2-3	ASU3-1
IM	***0.0350***	***0.2810***	***0.0700***	***0.2100***	***0.0180***	***0.0700***	***0.0350***	***0.2810***
MIM	0.0352	0.2804	0.0700	0.2103	0.0179	0.0700	0.0349	0.2814
COV	0.018	0.004	0.010	0.006	0.016	0.012	0.017	0.004

Repeatability 2 (IOPS)
Measured Intensity Multiplier and Coefficient of Variation

	ASU1-1	ASU1-2	ASU1-3	ASU1-4	ASU2-1	ASU2-2	ASU2-3	ASU3-1
IM	***0.0350***	***0.2810***	***0.0700***	***0.2100***	***0.0180***	***0.0700***	***0.0350***	***0.2810***
MIM	0.0349	0.2810	0.0700	0.2101	0.0180	0.0699	0.0350	0.2811
COV	0.004	0.001	0.005	0.002	0.005	0.003	0.007	0.002

Data Persistence Test

Clause 6

The Data Persistence Test demonstrates the Tested Storage Configuration (TSC):

- *Is capable of maintain data integrity across a power cycle.*
- *Ensures the transfer of data between Logical Volumes and host systems occurs without corruption or loss.*

The SPC-1 Workload Generator will write 16 block I/O requests at random over the total Addressable Storage Capacity of the TSC for ten (10) minutes at a minimum of 25% of the load used to generate the SPC-1 IOPS™ primary metric. The bit pattern selected to be written to each block as well as the address of the block will be retained in a log file.

The Tested Storage Configuration (TSC) will be shutdown and restarted using a power off/power on cycle at the end of the above sequence of write operations. In addition, any caches employing battery backup must be flushed/emptied.

The SPC-1 Workload Generator will then use the above log file to verify each block written contains the correct bit pattern.

Clause 9.4.3.8

The following content shall appear in this section of the FDR:

1. *A listing or screen image of all input parameters supplied to the Workload Generator.*
2. *For the successful Data Persistence Test Run, a table illustrating key results. The content, appearance, and format of this table are specified in Table 9-12. Information displayed in this table shall be obtained from the Test Run Results File referenced below in #3.*
3. *For the successful Data Persistence Test Run, the human readable Test Run Results File produced by the Workload Generator.*

SPC-1 Workload Generator Input Parameters

The SPC-1 Workload Generator input parameters for the Sustainability, IOPS, Response Time Ramp, Repeatability, and Persistence Test Runs are documented in "Appendix E: SPC-1 Workload Generator Input Parameters" on Page 97.

Data Persistence Test Results File

A link to each test result file generated from each Data Persistence Test is listed below.

Persistence 1 Test Results File

Persistence 2 Test Results File

Data Persistence Test Results

Data Persistence Test Results	
Data Persistence Test Run Number: 1	
Total Number of Logical Blocks Written	46,542,240
Total Number of Logical Blocks Verified	42,222,016
Total Number of Logical Blocks that Failed Verification	0
Time Duration for Writing Test Logical Blocks	10 minutes
Size in Bytes of each Logical Block	512
Number of Failed I/O Requests in the process of the Test	0

In some cases the same address was the target of multiple writes, which resulted in more Logical Blocks Written than Logical Blocks Verified. In the case of multiple writes to the same address, the pattern written and verified must be associated with the last write to that address.

PRICED STORAGE CONFIGURATION AVAILABILITY DATE

Clause 9.2.4.9

The committed delivery data for general availability (Availability Date) of all products that comprise the Priced Storage Configuration must be reported. When the Priced Storage Configuration includes products or components with different availability dates, the reported Availability Date for the Priced Storage Configuration must be the date at which all components are committed to be available.

The Fujitsu Storage Systems ETERNUS DX80 as documented in this Full Disclosure Report is currently available for customer purchase and shipment.

PRICING INFORMATION

Clause 9.4.3.3.6

The Executive Summary shall contain a pricing spreadsheet as documented in Clause 8.3.1.

Pricing information may found in the Priced Storage Configuration Pricing section on page 14.

TESTED STORAGE CONFIGURATION (TSC) AND PRICED STORAGE CONFIGURATION DIFFERENCES

Clause 9.4.3.3.7

The Executive Summary shall contain a pricing a list of all differenced between the Tested Storage Configuration (TSC) and the Priced Storage Configuration.

A list of all differences between the Tested Storage Configuration (TSC) and Priced Storage Configuration may be found in the Executive Summary portion of this document on page 14.

ANOMALIES OR IRREGULARITIES

Clause 9.4.3.10

The FDR shall include a clear and complete description of any anomalies or irregularities encountered in the course of executing the SPC-1 benchmark that may in any way call into question the accuracy, verifiability, or authenticity of information published in this FDR.

There were no anomalies or irregularities encountered during the SPC-1 Remote Audit of the Fujitsu Storage Systems ETERNUS DX80.

APPENDIX A: SPC-1 GLOSSARY

"Decimal" *(powers of ten)* Measurement Units

In the storage industry, the terms "kilo", "mega", "giga", "tera", "peta", and "exa" are commonly used prefixes for computing performance and capacity. For the purposes of the SPC workload definitions, all of the following terms are defined in "powers of ten" measurement units.

- A kilobyte (KB) is equal to 1,000 (10^3) bytes.
- A megabyte (MB) is equal to 1,000,000 (10^6) bytes.
- A gigabyte (GB) is equal to 1,000,000,000 (10^9) bytes.
- A terabyte (TB) is equal to 1,000,000,000,000 (10^{12}) bytes.
- A petabyte (PB) is equal to 1,000,000,000,000,000 (10^{15}) bytes
- An exabyte (EB) is equal to 1,000,000,000,000,000,000 (10^{18}) bytes

"Binary" *(powers of two)* Measurement Units

The sizes reported by many operating system components use "powers of two" measurement units rather than "power of ten" units. The following standardized definitions and terms are also valid and may be used in this document.

- A kibibyte (KiB) is equal to 1,024 (2^{10}) bytes.
- A mebibyte (MiB) is equal to 1,048,576 (2^{20}) bytes.
- A gigibyte (GiB) is equal to 1,073,741,824 (2^{30}) bytes.
- A tebibyte (TiB) is equal to 1,099,511,627,776 (2^{40}) bytes.
- A pebibyte (PiB) is equal to 1,125,899,906,842,624 (2^{50}) bytes.
- An exbibyte (EiB) is equal to 1,152,921,504,606,846,967 (2^{60}) bytes.

SPC-1 Data Repository Definitions

Total ASU Capacity: The total storage capacity read and written in the course of executing the SPC-1 benchmark.

Application Storage Unit (ASU): The logical interface between the storage and SPC-1 Workload Generator. The three ASUs (Data, User, and Log) are typically implemented on one or more Logical Volume.

Logical Volume: The division of Addressable Storage Capacity into individually addressable logical units of storage used in the SPC-1 benchmark. Each Logical Volume is implemented as a single, contiguous address space.

Addressable Storage Capacity: The total storage (sum of Logical Volumes) that can be read and written by application programs such as the SPC-1 Workload Generator.

Configured Storage Capacity: This capacity includes the Addressable Storage Capacity and any other storage (parity disks, hot spares, etc.) necessary to implement the Addressable Storage Capacity.

Physical Storage Capacity: The formatted capacity of all storage devices physically present in the Tested Storage Configuration (TSC).

Data Protection Overhead: The storage capacity required to implement the selected level of data protection.

Required Storage: The amount of Configured Storage Capacity required to implement the Addressable Storage Configuration, excluding the storage required for the three ASUs.

Global Storage Overhead: The amount of Physical Storage Capacity that is required for storage subsystem use and unavailable for use by application programs.

Total Unused Storage: The amount of storage capacity available for use by application programs but not included in the Total ASU Capacity.

SPC-1 Data Protection Levels

Protected: This level will ensure data protection in the event of a single point of failure of any configured storage device. A brief description of the data protection utilized is included in the Executive Summary.

Unprotected: No claim of data protection is asserted in the event of a single point of failure.

SPC-1 Test Execution Definitions

Average Response Time: The sum of the Response Times for all Measured I/O Requests divided by the total number of Measured I/O Requests.

Completed I/O Request: An I/O Request with a Start Time and a Completion Time (see "I/O Completion Types" below).

Completion Time: The time recorded by the Workload Generator when an I/O Request is satisfied by the TSC as signaled by System Software.

Data Rate: The data transferred in all Measured I/O Requests in an SPC-1 Test Run divided by the length of the Test Run in seconds.

Expected I/O Count: For any given I/O Stream and Test Phase, the product of 50 times the BSU level, the duration of the Test Phase in seconds, and the Intensity Multiplier for that I/O Stream.

Failed I/O Request: Any I/O Request issued by the Workload Generator that could not be completed or was signaled as failed by System Software. A Failed I/O Request has no Completion Time (see "I/O Completion Types" below).

I/O Request Throughput: The total number of Measured I/O requests in an SPC-1 Test Run divided by the duration of the Measurement Interval in seconds.

In-Flight I/O Request: An I/O Request issued by the I/O Command Generator to the TSC that has a recorded Start Time, but does not complete within the Measurement Interval (see "I/O Completion Types" below).

Measured I/O Request: A Completed I/O Request with a Completion Time occurring within the Measurement Interval (see "I/O Completion Types" below).

Measured Intensity Multiplier: The percentage of all Measured I/O Requests that were issued by a given I/O Stream.

Measurement Interval: The finite and contiguous time period, after the TSC has reached Steady State, when data is collected by a Test Sponsor to generate an SPC-1 test result or support an SPC-1 test result.

Ramp-Up: The time required for the Benchmark Configuration (BC) to produce Steady State throughput after the Workload Generator begins submitting I/O Requests to the TSC for execution.

Ramp-Down: The time required for the BC to complete all I/O Requests issued by the Workload Generator. The Ramp-Down period begins when the Workload Generator ceases to issue new I/O Requests to the TSC.

Response Time: The Response Time of a Measured I/O Request is its Completion Time minus its Start Time.

Start Time: The time recorded by the Workload Generator when an I/O Request is submitted, by the Workload Generator, to the System Software for execution on the Tested Storage Configuration (TSC).

Start-Up: The period that begins after the Workload Generator starts to submit I/O requests to the TSC and ends at the beginning of the Measurement Interval.

Shut-Down: The period between the end of the Measurement Interval and the time when all I/O Requests issued by the Workload Generator have completed or failed.

Steady State: The consistent and sustainable throughput of the TSC. During this period the load presented to the TSC by the Workload Generator is constant.

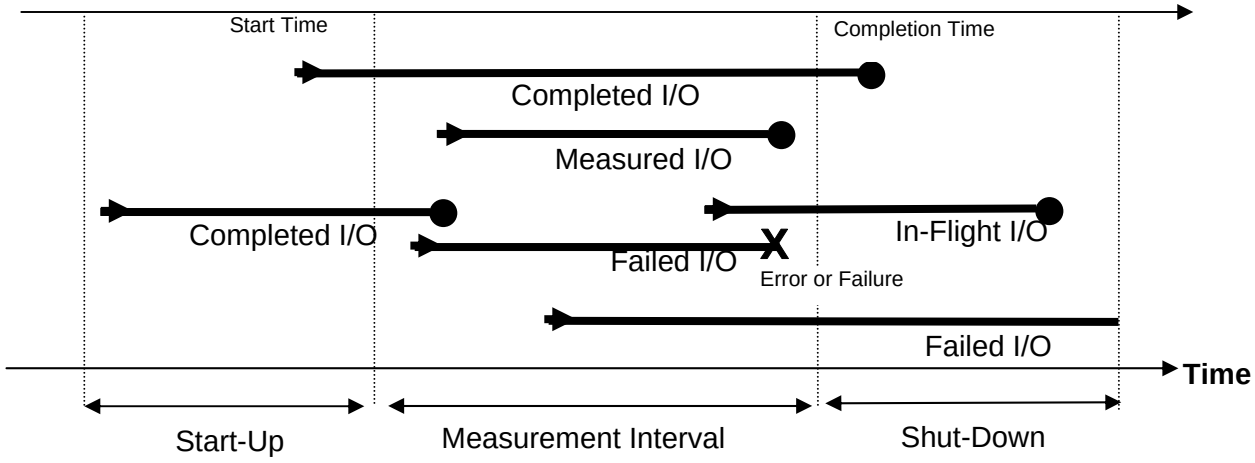
Test: A collection of Test Phases and or Test Runs sharing a common objective.

Test Run: The execution of SPC-1 for the purpose of producing or supporting an SPC-1 test result. SPC-1 Test Runs may have a finite and measured Ramp-Up period, Start-Up

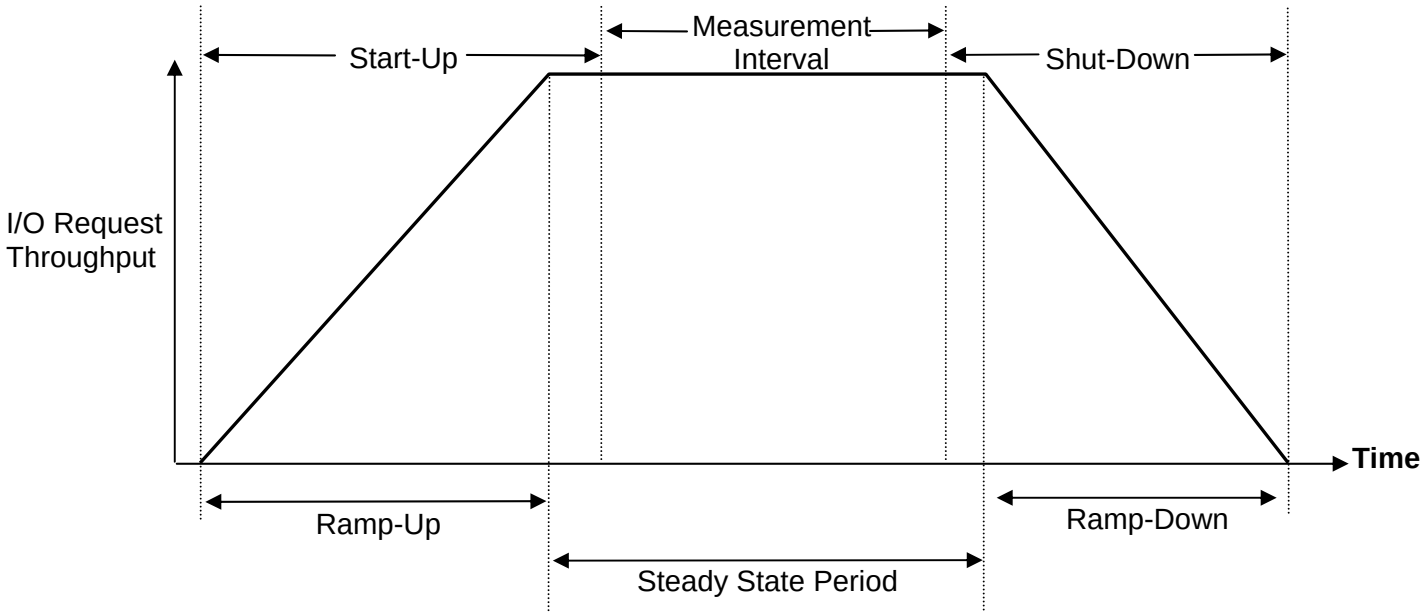
period, Shut-Down period, and Ramp-Down period as illustrated in the "SPC-1 Test Run Components" below. All SPC-1 Test Runs shall have a Steady State period and a Measurement Interval.

Test Phase: A collection of one or more SPC-1 Test Runs sharing a common objective and intended to be run in a specific sequence.

I/O Completion Types



SPC-1 Test Run Components



APPENDIX B: CUSTOMER TUNABLE PARAMETERS AND OPTIONS

Solaris Parameter Adjustments

The following settings were made the Solaris **/etc/system** control file information for execution of the SPC-1 Workload Generator on the SPARC Enterprise M8000.

```
*ident      "@(#)system  1.18   97/06/27 SMI" /* SVR4 1.5 */
*
* SYSTEM SPECIFICATION FILE
*

* moddir:
*
*    Set the search path for modules.  This has a format similar to the
*    csh path variable. If the module isn't found in the first directory
*    it tries the second and so on. The default is /kernel /usr/kernel
*
*    Example:
*           moddir: /kernel /usr/kernel /other/modules



* root device and root filesystem configuration:
*
*    The following may be used to override the defaults provided by
*    the boot program:
*
*    rootfs:             Set the filesystem type of the root.
*
*    rootdev:      Set the root device.  This should be a fully
*                  expanded physical pathname.  The default is the
*                  physical pathname of the device where the boot
*                  program resides.  The physical pathname is
*                  highly platform and configuration dependent.
*
*    Example:
*           rootfs:ufs
*           rootdev:/sbus@1,f8000000/esp@0,800000/sd@3,0:a
*
*    (Swap device configuration should be specified in /etc/vfstab.)



* exclude:
*
*    Modules appearing in the moddir path which are NOT to be loaded,
*    even if referenced. Note that `exclude' accepts either a module name,
*    or a filename which includes the directory.
*
*    Examples:
*           exclude: win
*           exclude: sys/shmsys



* forceload:
*
*    Cause these modules to be loaded at boot time, (just before mounting
*    the root filesystem) rather than at first reference. Note that
*    forceload expects a filename which includes the directory. Also
```

```
*    note that loading a module does not necessarily imply that it will
*    be installed.
*
*    Example:
*           forceload: drv/foo



* set:
*
*    Set an integer variable in the kernel or a module to a new value.
*    This facility should be used with caution.  See system(4).
*
*    Examples:
*
*    To set variables in 'unix':
*
*           set nautopush=32
*           set maxusers=40
*
*    To set a variable named 'debug' in the module named 'test_module'
*
*           set test_module:debug = 0x13

* Begin FJSVssf (do not edit)
set ftrace_atboot = 1
set kmem_flags = 0x100
set kmem_lite_maxalign = 8192
* End FJSVssf (do not edit)
forceload: drv/fjpfca
set heaplp_use_stlb=0
set autoup=480
set drmach:fmem_timeout=30
set pcie:pcie_aer_ce_mask=0x2001
set mc-opl:mc_max_rewrite_loop=20000
set maxfastscan=0x2000
```

The following settings were made in the Solaris **/etc/profile** login control file for execution of the SPC-1 Workload Generator as well. These are standard settings that were not changed for the benchmark.

```
#ident      "@(#)profile 1.19   01/03/13 SMI" /* SVr4.0 1.3 */

# The profile that all logins get before using their own .profile.

trap ""  2 3
export LOGNAME PATH

if [ "$TERM" = "" ]
then
     if /bin/i386
     then
           TERM=sun-color
     else
           TERM=sun
     fi
     export TERM
fi

#    Login and -su shells get /etc/profile services.
```

```
#    -rsh is given its environment in its .profile.

case "$0" in
-sh | -ksh | -jsh | -bash)

     if [ ! -f .hushlogin ]
     then
            /usr/sbin/quota
            #      Allow the user to break the Message-Of-The-Day only.
            trap "trap '' 2"  2
            /bin/cat -s /etc/motd
            trap "" 2

            /bin/mail -E
            case $? in
            0)
                   echo "You have new mail."
                   ;;
            2)
                   echo "You have mail."
                   ;;
            esac
     fi
esac

umask 022
trap  2 3

LD_LIBRARY_PATH=/usr/local/spc/spc1
export LD_LIBRARY_PATH
```

Entries in "sd.conf"

The following entries in sd.conf were defines to enable the Emulex HBAs for accessing the LUNs defined in the Fujitsu SPARC Enterprise M8000 Host System.

```
#
# Copyright 2006 Sun Microsystems, Inc.  All rights reserved.
# Use is subject to license terms.
#
#ident     "@(#)sd.conf 1.10   06/02/08 SMI"

name="sd" class="scsi" class_prop="atapi"
     target=0 lun=0;

name="sd" class="scsi" class_prop="atapi"
     target=0 lun=1;

name="sd" class="scsi" class_prop="atapi"
     target=0 lun=2;

name="sd" class="scsi" class_prop="atapi"
     target=0 lun=3;

name="sd" class="scsi" class_prop="atapi"
     target=0 lun=4;

name="sd" class="scsi" class_prop="atapi"
     target=0 lun=5;
```

```
name="sd" class="scsi" class_prop="atapi"
     target=0 lun=6;

name="sd" class="scsi" class_prop="atapi"
     target=0 lun=7;

name="sd" class="scsi" class_prop="atapi"
     target=0 lun=8;

name="sd" class="scsi" class_prop="atapi"
     target=0 lun=9;

name="sd" class="scsi" class_prop="atapi"
     target=0 lun=10;

name="sd" class="scsi" class_prop="atapi"
     target=0 lun=11;

name="sd" class="scsi" class_prop="atapi"
     target=0 lun=12;

name="sd" class="scsi" class_prop="atapi"
     target=0 lun=13;

name="sd" class="scsi" class_prop="atapi"
     target=0 lun=14;

name="sd" class="scsi" class_prop="atapi"
     target=0 lun=15;

name="sd" class="scsi" class_prop="atapi"
     target=0 lun=16;

name="sd" class="scsi" class_prop="atapi"
     target=0 lun=17;

name="sd" class="scsi" class_prop="atapi"
     target=0 lun=18;

name="sd" class="scsi" class_prop="atapi"
     target=0 lun=19;

name="sd" class="scsi" class_prop="atapi"
     target=0 lun=20;

name="sd" class="scsi" class_prop="atapi"
     target=0 lun=21;

name="sd" class="scsi" class_prop="atapi"
     target=0 lun=22;

name="sd" class="scsi" class_prop="atapi"
     target=0 lun=23;

name="sd" class="scsi" class_prop="atapi"
     target=0 lun=24;

name="sd" class="scsi" class_prop="atapi"
     target=0 lun=25;

name="sd" class="scsi" class_prop="atapi"
     target=0 lun=26;
```

```
name="sd" class="scsi" class_prop="atapi"
     target=0 lun=27;

name="sd" class="scsi" class_prop="atapi"
     target=0 lun=28;

name="sd" class="scsi" class_prop="atapi"
     target=0 lun=29;

name="sd" class="scsi" class_prop="atapi"
     target=0 lun=30;

name="sd" class="scsi" class_prop="atapi"
     target=0 lun=31;

name="sd" class="scsi" class_prop="atapi"
     target=0 lun=32;

name="sd" class="scsi" class_prop="atapi"
     target=0 lun=33;

name="sd" class="scsi" class_prop="atapi"
     target=0 lun=34;

name="sd" class="scsi" class_prop="atapi"
     target=0 lun=35;

name="sd" class="scsi" class_prop="atapi"
     target=0 lun=36;

name="sd" class="scsi" class_prop="atapi"
     target=0 lun=37;

name="sd" class="scsi" class_prop="atapi"
     target=0 lun=38;

name="sd" class="scsi" class_prop="atapi"
     target=0 lun=39;

name="sd" class="scsi" class_prop="atapi"
     target=0 lun=40;

name="sd" class="scsi" class_prop="atapi"
     target=0 lun=41;

name="sd" class="scsi" class_prop="atapi"
     target=0 lun=42;

name="sd" class="scsi" class_prop="atapi"
     target=0 lun=43;

name="sd" class="scsi" class_prop="atapi"
     target=0 lun=44;

name="sd" class="scsi" class_prop="atapi"
     target=0 lun=45;

name="sd" class="scsi" class_prop="atapi"
     target=0 lun=46;

name="sd" class="scsi" class_prop="atapi"
     target=0 lun=47;
```

```
name="sd" class="scsi" class_prop="atapi"
     target=0 lun=48;

name="sd" class="scsi" class_prop="atapi"
     target=0 lun=49;

name="sd" class="scsi" class_prop="atapi"
     target=0 lun=50;

name="sd" class="scsi" class_prop="atapi"
     target=0 lun=51;

name="sd" class="scsi" class_prop="atapi"
     target=0 lun=52;

name="sd" class="scsi" class_prop="atapi"
     target=0 lun=53;

name="sd" class="scsi" class_prop="atapi"
     target=0 lun=54;

name="sd" class="scsi" class_prop="atapi"
     target=0 lun=55;

name="sd" class="scsi" class_prop="atapi"
     target=0 lun=56;

name="sd" class="scsi" class_prop="atapi"
     target=0 lun=57;

name="sd" class="scsi" class_prop="atapi"
     target=0 lun=58;

name="sd" class="scsi" class_prop="atapi"
     target=0 lun=59;

name="sd" class="scsi" class_prop="atapi"
     target=0 lun=60;

name="sd" class="scsi" class_prop="atapi"
     target=0 lun=61;

name="sd" class="scsi" class_prop="atapi"
     target=0 lun=62;

name="sd" class="scsi" class_prop="atapi"
     target=0 lun=63;

name="sd" class="scsi" class_prop="atapi"
     target=0 lun=64;

name="sd" class="scsi" class_prop="atapi"
     target=0 lun=65;

name="sd" class="scsi" class_prop="atapi"
     target=0 lun=66;

name="sd" class="scsi" class_prop="atapi"
     target=0 lun=67;

name="sd" class="scsi" class_prop="atapi"
     target=0 lun=68;
```

```
name="sd" class="scsi" class_prop="atapi"
     target=0 lun=69;

name="sd" class="scsi" class_prop="atapi"
     target=0 lun=70;

name="sd" class="scsi" class_prop="atapi"
     target=0 lun=71;

name="sd" class="scsi" class_prop="atapi"
     target=0 lun=72;

name="sd" class="scsi" class_prop="atapi"
     target=0 lun=73;

name="sd" class="scsi" class_prop="atapi"
     target=0 lun=74;

name="sd" class="scsi" class_prop="atapi"
     target=0 lun=75;

name="sd" class="scsi" class_prop="atapi"
     target=0 lun=76;

name="sd" class="scsi" class_prop="atapi"
     target=0 lun=77;

name="sd" class="scsi" class_prop="atapi"
     target=0 lun=78;

name="sd" class="scsi" class_prop="atapi"
     target=0 lun=79;

name="sd" class="scsi" class_prop="atapi"
     target=0 lun=80;

name="sd" class="scsi" class_prop="atapi"
     target=0 lun=81;

name="sd" class="scsi" class_prop="atapi"
     target=0 lun=82;

name="sd" class="scsi" class_prop="atapi"
     target=0 lun=83;

name="sd" class="scsi" class_prop="atapi"
     target=0 lun=84;

name="sd" class="scsi" class_prop="atapi"
     target=0 lun=85;

name="sd" class="scsi" class_prop="atapi"
     target=0 lun=86;

name="sd" class="scsi" class_prop="atapi"
     target=0 lun=87;

name="sd" class="scsi" class_prop="atapi"
     target=0 lun=88;

name="sd" class="scsi" class_prop="atapi"
     target=0 lun=89;
```

```
name="sd" class="scsi" class_prop="atapi"
     target=0 lun=90;

name="sd" class="scsi" class_prop="atapi"
     target=0 lun=91;

name="sd" class="scsi" class_prop="atapi"
     target=0 lun=92;

name="sd" class="scsi" class_prop="atapi"
     target=0 lun=93;

name="sd" class="scsi" class_prop="atapi"
     target=0 lun=94;

name="sd" class="scsi" class_prop="atapi"
     target=0 lun=95;

name="sd" class="scsi" class_prop="atapi"
     target=0 lun=96;

name="sd" class="scsi" class_prop="atapi"
     target=0 lun=97;

name="sd" class="scsi" class_prop="atapi"
     target=0 lun=98;

name="sd" class="scsi" class_prop="atapi"
     target=0 lun=99;

name="sd" class="scsi" class_prop="atapi"
     target=0 lun=100;

name="sd" class="scsi" class_prop="atapi"
     target=0 lun=101;

name="sd" class="scsi" class_prop="atapi"
     target=0 lun=102;

name="sd" class="scsi" class_prop="atapi"
     target=0 lun=103;

name="sd" class="scsi" class_prop="atapi"
     target=0 lun=104;

name="sd" class="scsi" class_prop="atapi"
     target=0 lun=105;

name="sd" class="scsi" class_prop="atapi"
     target=0 lun=106;

name="sd" class="scsi" class_prop="atapi"
     target=0 lun=107;

name="sd" class="scsi" class_prop="atapi"
     target=0 lun=108;

name="sd" class="scsi" class_prop="atapi"
     target=0 lun=109;

name="sd" class="scsi" class_prop="atapi"
     target=0 lun=110;
```

```
name="sd" class="scsi" class_prop="atapi"
     target=0 lun=111;

name="sd" class="scsi" class_prop="atapi"
     target=0 lun=112;

name="sd" class="scsi" class_prop="atapi"
     target=0 lun=113;

name="sd" class="scsi" class_prop="atapi"
     target=0 lun=114;

name="sd" class="scsi" class_prop="atapi"
     target=0 lun=115;

name="sd" class="scsi" class_prop="atapi"
     target=0 lun=116;

name="sd" class="scsi" class_prop="atapi"
     target=0 lun=117;

name="sd" class="scsi" class_prop="atapi"
     target=0 lun=118;

name="sd" class="scsi" class_prop="atapi"
     target=0 lun=119;

name="sd" class="scsi" class_prop="atapi"
     target=0 lun=120;

name="sd" class="scsi" class_prop="atapi"
     target=0 lun=121;

name="sd" class="scsi" class_prop="atapi"
     target=0 lun=122;

name="sd" class="scsi" class_prop="atapi"
     target=0 lun=123;

name="sd" class="scsi" class_prop="atapi"
     target=0 lun=124;

name="sd" class="scsi" class_prop="atapi"
     target=0 lun=125;

name="sd" class="scsi" class_prop="atapi"
     target=0 lun=126;

name="sd" class="scsi" class_prop="atapi"
     target=0 lun=127;

name="sd" class="scsi" class_prop="atapi"
     target=0 lun=128;

name="sd" class="scsi" class_prop="atapi"
     target=0 lun=129;

name="sd" class="scsi" class_prop="atapi"
     target=0 lun=130;

name="sd" class="scsi" class_prop="atapi"
     target=0 lun=131;
```

```
name="sd" class="scsi" class_prop="atapi"
     target=0 lun=132;

name="sd" class="scsi" class_prop="atapi"
     target=0 lun=133;

name="sd" class="scsi" class_prop="atapi"
     target=0 lun=134;

name="sd" class="scsi" class_prop="atapi"
     target=0 lun=135;

name="sd" class="scsi" class_prop="atapi"
     target=0 lun=136;

name="sd" class="scsi" class_prop="atapi"
     target=0 lun=137;

name="sd" class="scsi" class_prop="atapi"
     target=0 lun=138;

name="sd" class="scsi" class_prop="atapi"
     target=0 lun=139;

name="sd" class="scsi" class_prop="atapi"
     target=0 lun=140;

name="sd" class="scsi" class_prop="atapi"
     target=0 lun=141;

name="sd" class="scsi" class_prop="atapi"
     target=0 lun=142;

name="sd" class="scsi" class_prop="atapi"
     target=0 lun=143;

name="sd" class="scsi" class_prop="atapi"
     target=0 lun=144;

name="sd" class="scsi" class_prop="atapi"
     target=0 lun=145;

name="sd" class="scsi" class_prop="atapi"
     target=0 lun=146;

name="sd" class="scsi" class_prop="atapi"
     target=0 lun=147;

name="sd" class="scsi" class_prop="atapi"
     target=0 lun=148;

name="sd" class="scsi" class_prop="atapi"
     target=0 lun=149;

name="sd" class="scsi" class_prop="atapi"
     target=0 lun=150;

name="sd" class="scsi" class_prop="atapi"
     target=0 lun=151;

name="sd" class="scsi" class_prop="atapi"
     target=0 lun=152;
```

```
name="sd" class="scsi" class_prop="atapi"
     target=0 lun=153;

name="sd" class="scsi" class_prop="atapi"
     target=0 lun=154;

name="sd" class="scsi" class_prop="atapi"
     target=0 lun=155;

name="sd" class="scsi" class_prop="atapi"
     target=0 lun=156;

name="sd" class="scsi" class_prop="atapi"
     target=0 lun=157;

name="sd" class="scsi" class_prop="atapi"
     target=0 lun=158;

name="sd" class="scsi" class_prop="atapi"
     target=0 lun=159;

name="sd" class="scsi" class_prop="atapi"
     target=1 lun=0;

name="sd" class="scsi" class_prop="atapi"
     target=2 lun=0;

name="sd" class="scsi" class_prop="atapi"
     target=3 lun=0;

name="sd" class="scsi"
     target=4 lun=0;

name="sd" class="scsi"
     target=5 lun=0;

name="sd" class="scsi"
     target=6 lun=0;

name="sd" class="scsi"
     target=8 lun=0;

name="sd" class="scsi"
     target=9 lun=0;

name="sd" class="scsi"
     target=10 lun=0;

name="sd" class="scsi"
     target=11 lun=0;

name="sd" class="scsi"
     target=12 lun=0;

name="sd" class="scsi"
     target=13 lun=0;

name="sd" class="scsi"
     target=14 lun=0;

name="sd" class="scsi"
     target=15 lun=0;
```

```
#
# Enable Target 7 for the mpt SCSI/SAS/SATA driver.  Target 7 has
# traditionally been reserved for legacy SCSI HBAs, but SAS controllers
# supported by the mpt driver do not use target 7 for that purpose.
# Enabling Target 7 allows the use of 8 disks on those controllers.
#
name="sd" parent="mpt"
     target=7 lun=0;
```

Emulex HBA Configuration Parameters

These parameters are set in **fjpfca.conf** to provide an adjustment in the maximum number of outstanding commands to each of the SCSI target devices.

```
#
# All Rights Reserved, Copyright (c) FUJITSU LIMITED  2000
#
#ident "@(#)$Id: fjpfca.conf,v 3.1.1.1 2001/04/20 11:19:47 hiroki Exp $ FUJITSU"

# The fjpfca driver support connection to NL_port(FC-AL) and
# F_Port/FL_Port(fabric).
# It is necessary to define "port" property in order to communicate
# with the fabric or N_port target. In addition, it is necessary
# to define "fcp-bind-target" property in order to communicate
# with the fabric. These need not be defined for FC-AL.
# Other properties like "alias" and "max-throttle" are optional.

# Alias name definition
# You can create an alias definition for a specific WWN
# with "alias" property.
# SYNOPSIS:
#   alias="alias-name:wwn", ...;
# EXAMPLE:
#   alias="TARGET_A:0x100000a0b8030001","TARGET_B:0x100000a0b8030002";
#
#alias=
#    "TARGET_0A:0x100000a0b8030001",
#    "TARGET_1A:0x100000a0b8030002",
#    "TARGET_0B:0x100000a0b8030003",
#    "TARGET_1B:0x100000a0b8030004";

# Port type definition
# The port type definition sets the port mode for a specific instance.
# If the "port" property is not defined, the fjpfca driver
# will determine the port mode automatically during the initialization.
# SYNOPSIS:
#   port="instance-name:[nport|loop]", ...;
# EXAMPLE:
#   port="fjpfca0:nport","fjpfca1:loop";
#
#port=
#    "fjpfca0:loop",
#    "fjpfca1:loop",
#    "fjpfca2:loop",
#    "fjpfca3:loop";

# Target binding definition
# fcp-bind-target binds a specific instance to a target ID.
# You can use defined alias in "alias" property for the WWN.
# SYNOPSIS:
```

```
#   fcp-bind-target="[target-name:[wwn|alias-name]", ...;
# EXAMPLE:
#   fcp-bind-target= "fjpfca0t0:0x100000a0b8030001","fjpfca1t0:TARGET_B";
#
##fcp-bind-target=
##   "fjpfca0t0:0x100000a0b8030001",
##   "fjpfca0t1:0x100000a0b8030003",
##   "fjpfca1t0:TARGET_1A",
##   "fjpfca1t1:TARGET_1B";

# Number of maximum commands per target definition
# The driver uses the value specified by the max-throttle property
# as a number a target of commands which can be issued simultaneously.
# SYNOPSIS:
#   max-throttle="[target-name:number]", ...;
# EXAMPLE:
#   max-throttle="fjpfca0t0:240","fjpfca1t0:240";
#
#max-throttle=
#    "fjpfca0t0:240",
#    "fjpfca0t1:128",
#    "fjpfca1t0:240",
#    "fjpfca1t1:128";

max-throttle-all=35;
```

APPENDIX C: TESTED STORAGE CONFIGURATION (TSC) CREATION

The ETERNUS Storage Array is configured using an interactive on-line tool called ETERNUS Administrator. When an ETERNUS DX80 unit is delivered from the factory, there are a set of default RAID Groups and LUNs defined, and the tool is used to modify the configuration to that needed in the customer environment. The following paragraphs outline use of this tool to define the configuration outlined within this FDR. The primary definitions for use in making the configuration are provided through an Excel spreadsheet, called a Design Sheet. Note that the capacity calculations on the spreadsheet are an estimate, used to choose the sizes of the volumes used to make up the ASUs for the benchmark storage definitions. The Design sheets for the TSC are provided via the following hyperlink:

DX80_config_r_32rg_640lun-cw

This design sheet is developed by the Fujitsu SE, in consultation with the customer, and is provided to the Fujitsu factory when the order for the system is placed. The factory will configure the system according to this design, using internal Fujitsu tools.

Should a customer need to change the delivered configuration, then a series of steps must be followed, using ETERNUS Administrator. The Web GUI User Guide for the ETERNUS Administrator on the DX80 is available for download from:

http://ts.fujitsu.com/support/manuals.html

Upon entry, select Product DX80 to reach the list of manuals. Select ETERNUS DX60/DX80 – Web GUI – User Guide, and then download the .pdf manual.

To define a new RAID Group the following steps are used:

1. Assuming that there are available drives to assign to a new RAID Group, select "RAID Group Creation" tool in the main tool bar.
2. The Define RAID Groups screen will be presented. Select the RAID Group Creation tool. Use the Browse button to obtain a list of the drives. Select Free drives to be included in the RAID Group and the desired RAID Level, leaving the Assigned CM selection to Auto. You may optionally assign the RAID Group a name and click the "Next" button. A confirmation screen is provided before the action is committed. Click the "Finish" button to complete the definition of the RAID Group.
3. Additional RAID Groups can be defined by repeating the process.

It is necessary to define one or more Logical Volumes within each of the defined RAID Groups, using the following steps:

1. Select "Create Volume" Tool in the main tool bar.
2. The Create Logical Volume Screen (Volume Creation) screen will be presented, with a list of the RAID Groups defined, and the capacity of each (in MiB). Select the RAID Group in which a Logical Volume is to be defined, and click the "Next" button.
3. A blank name and default capacity of 1024 MB (1000 MiB) is presented. Up to the entire RAID Group may be used by putting in the capacity listed for the selected

RAID Group. A number of like sized volumes can be defined by setting a value in the "Volumes" field. A name may be optionally assigned to the volume. Once you have set the factors for the volume creation, click the "Create Volume" icon above the section of the screen where volumes to be created will be listed. Additional volumes may be included in the create operation by clicking the "Create Volume" icon again. When you have a list with all of the volumes you want to create, then click the "Next" button. A confirmation screen is provided before the action is committed. Click the "Finish" button on the configuration screen to create the volumes.

4. Additional Logical Volumes can be defined by repeating the process within the RAID group and for other RAID Groups.

The configuration plan for the SPC-1 Benchmark configuration has a SPARC Enterprise M8000 server directly connected from the two dual ported HBAs to Channel Adapter ports, 4 CA port connections in all. Each port was set up using the following:

1. Select "Volume Settings" Tool in the main tool bar.
2. Select "Host I/FManagement" Tool in the tool bar.
3. When the "Set FC_Port parameters" is clicked, the screen will be presented.
4. Select the "Ports" tab to review the CA Port parameters. Select a port from the tree on the left to access the settings for that port. As this is a direct connection from the server HBA port to the storage CA port, the default selection of FC-AL Connection, Loop-Id (Manual), 0x00, Class 3, and Affinity Mode Off with default Host Response apply. The only item that was changed for the benchmark was the selection of 4Gbit for the Transfer Rate. Click the "Apply" button to save the settings for the selected port.
5. With the selections complete, click the "OK" button to reach the confirmation dialog box – click "Yes" to complete the operations.
6. Each of the four ports are set up in the same manner.

The configuration plan for the SPC-1 Benchmark configuration assigns the 160 Logical Volumes as LUNs 0-159 on each of the Channel Adapter ports. There are 640 Logical Volumes in the defined configuration, 20 on each of the 32 RAID Groups, according to the configuration plan. The following steps are used to set the LUN mapping for each of the CA ports:

1. Select the "Host Affinity Groups" tab on the ETERNUS Administrator Window. This will list the various host affinity groups defined. Groups 00-03 apply to the ports with Host Affinity OFF, while group numbers 04 and greater apply to Host Affinity Groups associated with ports that have Host Affinity ON. Each port will show, under the Type column, "LUN Mapping", while the others will show "Host Affinity Group".
2. Select one of the port entries on the right side of the screen (not in the tree on the left side), which is going to have LUN mapping set up. This will enable the "Modify" button on the bottom of the screen.
3. Click the "Modify" button on the bottom of the screen and the Step 1 of 6: Host Affinity Group Name screen will be presented.

4. Enter a name to enable the "Next" button, and click the "Next" button. This will present the Step 3 of 6: Assign Volumes screen, which contains a list of the available volumes which may be assigned.
5. Select one or more of the Available Volumes for mapping, and click the "Add" button in the middle of the screen to include the volumes in the list for mapping. When all of the volumes to be mapped have been included in the list on the right for adding into the LUN Mapping list, click the "Next" button.
6. This presents the screen Step 4 of 6: LUN Mapping, which shows the list of the volumes selected, and default LUN assignments for each. The default LUN assignments may be changed by entry in the respective "SCSI LUN" column entries or using the spinner buttons on the respective LUN number entries. Select the "Next" button when all of the LUN assignments have been set, as required.
7. This presents the screen Step 6 of 6: Summary, which shows all of the LUN Mapping assignments for the selected Host Affinity Group (or Port in this case). If there are problems, use the "Back" button to return to previous screens to resolve the issues. In some cases, a Logical Volume may be included in more than one group mapping, and this is indicated in the "Duplicate Volume" section of the summary screen. Click the "Finish" button to complete the mapping configuration for the port.
8. The LUN mapping for each of the four ports are set up in the same manner.

The configuration plan also includes a Hot Spare drive, which are defined in much the same way as RAID Groups, using the following steps:

1. Select the "RAID Groups" tab on the ETERNUS Administrator Window. This will list the various RAID Groups that are defined, along with a family of buttons across the bottom of the pane.
2. Select the "Hot Spare" button, and the screen to "Select disks to register or delete HotSpare disk" will be displayed. This screen will show the current role of all of the disk drives installed in the system, by Drive Enclosure. Any drive that is in the "Free"state may be selected for assignment as a Hot Spare drive. Selecting a drive that is currently marked as a Hotspare, will change it to a pending Free state. Click the OK button, and after a confirming acknowledgment, the changes indicated will be made.

Each step along the way to completing the configuration does a small part, and the configuration plan provides the details of the specific entries that are defined, using the ETERNUS Administrator interface. For most customer systems, where the design sheets provide the complete configuration plan, the ETERNUS DX80 system is pre-configured at the factory. However, when the plan is not complete or not supplied with an order, a default configuration will be applied by the factory, based on the complement of components ordered.

Scripts and Commands used to Configure Storage Volumes

There are scripts, files, and commands used to create the logical representation of the TSC used in the benchmark measurement for the ETERNUS DX80 Storage system.

The **makesol** script is used to create the Solaris Volume Manager (SVM) logical volumes based on a configuration description file. This script is called by:

./makesol Test_DX80_32rg_B_2_4_svmake.txt

The Configuration Description file is created by a macro within the Configuration Plan Excel workbook and contains the list of the raw disks that are used to create the SVM logical volumes assigned to ASU1, ASU2, and ASU3. It is used as an input by the **makesol** script.

The SPC1 Configuration file is also created by a macro within the Configuration Plan Excel workbook, and contains the list of Solaris Logical Volumes that form the definitions for the three ASUs used by the benchmark, ASU1, ASU2, and ASU3.

The content of both the **makesol** script and the configuration description file appear below.

makesol

```
#!/bin/ksh
# Usage: usage
#           makesol configFile
#
LABELFILE="/tmp/makesollabel"
STATFILE="/tmp/makesolstat"
AWK=nawk
usage()
{
        echo "\nUsage: $0 configFile\n"
        exit 1
}

labelDisk()
{
     echo "l" > $LABELFILE
     echo "q" >> $LABELFILE
     format -s -f $LABELFILE $1
}

checkStat()
{
     typeset -i i=0
     del1=`grep $1 $STATFILE|$AWK '{ print $1 }'`
     if [ "$del1" != "" ] ; then
            for del in $del1
            do
                  i=0
                  while (( $i < $delete ))
                  do
                        if [ ${DELETE[(($i+1))]} == $del ] ; then
                              break
                        fi
                        i=$i+1
                  done
                  if (( $i == $delete )) ; then
                        delete=$delete+1
                        DELETE[$delete]=$del
                  fi
            done
     fi
}
```

```
getDiskSlice()
{
     vDisks=""
     for disk in ${DISKS[$1]}
     do
            ndisk=`echo $disk|$AWK 'BEGIN { FS="s"} ; { print $1 }'`
            vDisks=$vDisks$ndisk"s"$2" "
     done
}

makevol()
{
     typeset -i count=0
     typeset -i i=0
     typeset -i vcount
        tmp=`/usr/sbin/metastat -p|$AWK '{ print substr( $1, 2, length($1)-1 )}'`
     if [ "$tmp" == "" ] ; then
            i=0
     else
            for dgroup in $tmp
            do
                   if (( $dgroup > $i )) ; then
                          i=$dgroup
                   fi
            done
            i=$i+1
     fi
     while (( $count < $groups ))
     do
            count=$count+1
#echo "/usr/sbin/metainit d$i 1 ${DISK_COUNT[$count]} ${DISKS[$count]}
${STRIPE[$count]}"
            tmp=`/usr/sbin/metainit d$i 1 ${DISK_COUNT[$count]} ${DISKS[$count]}
${STRIPE[$count]}`
            i=$i+1
            if [ "${VCOUNT[$count]}" != "" ] ; then
                   vcount=1
                   while (( $vcount < ${VCOUNT[$count]} ))
                   do
                          getSlice $vcount
                          getDiskSlice $count $num
                          tmp=`/usr/sbin/metainit d$i 1 ${DISK_COUNT[$count]} $vDisks
${STRIPE[$count]}`
                          i=$i+1
                          vcount=$vcount+1
                   done
            fi
     done
}

checkDisk()
{
     typeset -i i=0
     tmp=$1"s"
     test=`grep $tmp /etc/vfstab`
     if [ "$test" != "" ] ; then
            echo "Found disk $1 in /etc/vfstab, we really shouldn't use it here"
            exit 4
     fi
     while (( $i < $groups ))
     do
            i=$i+1
            for disk in ${DISKS[$i]}
```

```
            do
                  tmp=$1"s0"
                  if [ "$disk" == $tmp ] ; then
                        echo "disk $1 repeated at line $lineno"
                        exit 4
                  fi
            done
         done
         disks=$disks+1
      part=$1"s0"
      DISKS[$groups]=${DISKS[$groups]}$part" "
      tmp=`prtvtoc -h /dev/dsk/$part 2>/dev/null`
      if [ $? != 0 ] ; then
            labelDisk $part
            tmp=`prtvtoc -h /dev/dsk/$part 2>/dev/null`
            if [ $? != 0 ] ; then
                  echo "prtvtoc failed for $part"
                  exit 4
            fi
      fi
      checkStat $1"s"
}

getSlice()
{
      num=0
         case $1 in
         0)
             num=0
                  ;;
         1)
                  num=1
                  ;;
         2|3|4|5|6)
                  (( num=$1+1 ))
                  ;;
         esac
}

setVtoc()
{
      typeset -i count=0
         typeset -i i=0
         while (( $i < $groups ))
         do
                  i=$i+1
                  for disk in ${DISKS[$i]}
                  do
                    if [ "${VCOUNT[$i]}" != "" ] ; then
                          sectors=`prtvtoc /dev/dsk/$disk 2>/dev/null|grep
"accessible cylinders"|$AWK '{ print $2 }'`
                          seccyl=`prtvtoc /dev/dsk/$disk 2>/dev/null|grep
"sectors/cylinder"|$AWK '{ print $2 }'`
                          (( sectors=$sectors-1 ))
                    fi
                    tmp=`prtvtoc -h /dev/dsk/$disk 2>/dev/null`
                    set $tmp
                    while (( $# > 5 ))
                    do
                          if (( $1 == 2 )) ; then
                             if [ "${VCOUNT[$i]}" == "" ] ; then
                                   echo "0 4 $3 $4 $5 $6" > $LABELFILE
                             else
```

```
                                        echo "* labelfile" > $LABELFILE
                                        (( secCount=$sectors/${VCOUNT[$i]} ))
                                        count=0
                                                (( sc=$secCount*$seccyl ))
                                                fs=$seccyl
                                        while (( $count < ${VCOUNT[$i]} ))
                                        do
                                               (( ls=$fs+$sc ))
                                               getSlice $count
                                               echo "$num 4 $3 $fs $sc $ls" >>
 $LABELFILE
                                                          count=$count+1
                                               (( fs=$fs+$sc ))
                                        done
                                fi
                                echo "$1 $2 $3 $4 $5 $6" >> $LABELFILE
                                tmp=`fmthard -s $LABELFILE /dev/rdsk/$disk`
                                break
                        fi
                        shift 6
                  done
                done
        done
 }

 delGroups()
 {
      typeset -i i=0
      if [ $DELETE_ALL == "yes" ] ; then
             tmp=`/usr/sbin/metastat -p |$AWK '{ print $1 }'`
             for del in $tmp
             do
                    tmp=`/usr/sbin/metaclear $del`
                    if [ $? != 0 ] ; then
                           echo "Failed to delete volume $del"
                           exit 4
                    fi
             done
             return
      fi
      while (( $i < $delete ))
      do
             i=$i+1
             tmp=`/usr/sbin/metaclear ${DELETE[$i]}`
             if [ $? != 0 ] ; then
                    echo "Failed to delete volume ${DELETE[$i]}"
                    exit 4
             fi
      done
 }

 addDisks()
 {
         typeset -i diskNum=0
         typeset -i count=$name
         typeset -i jump=1
         diskNum=${label#*d}
         if (( $diskNum < 10 ))
         then
                 diskPrefix=`echo $label|awk '{ print substr( $1, 0, length($1)-1 )
 }'`
         elif (( $diskNum < 100 ))
         then
```

```
                diskPrefix=`echo $label|awk '{ print substr( $1, 0, length($1)-2 )
}'`
        else
                diskPrefix=`echo $label|awk '{ print substr( $1, 0, length($1)-3 )
}'`
        fi
        if [ "$skip" != "" ]
        then
                jump=$skip
        fi
        count=$count-1
        while [ $count != 0 ]
        do
                count=$count-1
                diskNum=$diskNum+$jump
                diskName=$diskPrefix$diskNum
                checkDisk $diskName
        done

}

checkConfig()
{
        typeset -i lineno=1
        invg="no"
     DELETE_ALL="no"
        while read -r label name skip
        do
                case $label in
                "VOLUME_GROUP:")
                        VGNAME=$VGNAME$name" "
                        invg="yes"
                        groups=$groups+1
                        getSize="yes"
                        ;;
                "#")
                        ;;
                "")
                        ;;
            "VOLUME")
                        if [ "$invg" != "yes" ]
                        then
                                echo "invalid line in config file line=$lineno
data=\"$label $name\""
                         echo "VOLUME line must be in a volume_group definition"
                                exit 4
                        fi
                  tmp=`echo $name|grep ^[1-7]$`
                  if [ "$tmp" == "" ] ; then
                         echo "invalid line in config file line=$lineno
data=\"$label $name\""
                         echo "VOLUME count must be from 1-7"
                         exit 4
                  fi
                  VCOUNT[groups]=$name
                  ;;
                "STRIPE")
                        if [ "$invg" != "yes" ]
                        then
                                echo "invalid line in config file line=$lineno
data=\"$label $name\""
                                echo "STRIPE line must be in a volume_group
definition"
```

```
                                exit 4
                        fi
                        STRIPE[groups]="-i $name"
                        ;;
                "DELETE_ALL")
                        DELETE_ALL="yes"
                        ;;
                    "END")
                      DISK_COUNT[$groups]=$disks
                      disks=0
                            invg="no"
                            ;;
                    *)
                            if [ "$invg" != "yes" ]
                            then
                                    echo "invalid line in config file line=$lineno
 data=\"$label $name\""
                                    exit 4
                            fi
                            diskName=$label
                            checkDisk $diskName
                            if [ "$name" != "" ]
                            then
                                    addDisks
                            fi
                    esac
                    lineno=$lineno+1
            done < $CONFIG
 }


 # main()

            typeset -i delete=0
            typeset -i groups=0
            typeset -i disks=0
            test=`uname -a|grep "Linux"`
            if [ "$test" != "" ]
            then
                    AWK=awk
            fi
         case $# in
         1)
                CONFIG=$1
                echo "Doing solvm config from $1"
                ;;
         *)
                usage
                ;;
         esac
         tmp=`/usr/sbin/metadb`
         if [ "$tmp" == "" ] ; then
                echo "No replica database is defined"
                exit 4
         fi
         tmp=`/usr/sbin/metastat -p > $STATFILE`
         checkConfig
         delGroups
         setVtoc
         makevol
```

Test_DX80_32rg_B_2_4_svmake.txt

```
DELETE_ALL
VOLUME_GROUP: asu1-1 (d0)
STRIPE 8m
VOLUME 1
c2t0d4
c3t0d4
c6t0d4
c7t0d4
c2t0d24
c3t0d24
c6t0d24
c7t0d24
c2t0d44
c3t0d44
c6t0d44
c7t0d44
c2t0d64
c3t0d64
c6t0d64
c7t0d64
c2t0d84
c3t0d84
c6t0d84
c7t0d84
c2t0d104
c3t0d104
c6t0d104
c7t0d104
c2t0d124
c3t0d124
c6t0d124
c7t0d124
c2t0d144
c3t0d144
c6t0d144
c7t0d144
END
VOLUME_GROUP: asu1-2 (d1)
STRIPE 8m
VOLUME 1
c2t0d5
c3t0d5
c6t0d5
c7t0d5
c2t0d25
c3t0d25
c6t0d25
c7t0d25
c2t0d45
c3t0d45
c6t0d45
c7t0d45
c2t0d65
c3t0d65
c6t0d65
c7t0d65
c2t0d85
c3t0d85
c6t0d85
c7t0d85
c2t0d105
```

```
c3t0d105
c6t0d105
c7t0d105
c2t0d125
c3t0d125
c6t0d125
c7t0d125
c2t0d145
c3t0d145
c6t0d145
c7t0d145
END
VOLUME_GROUP: asu1-3 (d2)
STRIPE 8m
VOLUME 1
c2t0d6
c3t0d6
c6t0d6
c7t0d6
c2t0d26
c3t0d26
c6t0d26
c7t0d26
c2t0d46
c3t0d46
c6t0d46
c7t0d46
c2t0d66
c3t0d66
c6t0d66
c7t0d66
c2t0d86
c3t0d86
c6t0d86
c7t0d86
c2t0d106
c3t0d106
c6t0d106
c7t0d106
c2t0d126
c3t0d126
c6t0d126
c7t0d126
c2t0d146
c3t0d146
c6t0d146
c7t0d146
END
VOLUME_GROUP: asu1-4 (d3)
STRIPE 8m
VOLUME 1
c2t0d7
c3t0d7
c6t0d7
c7t0d7
c2t0d27
c3t0d27
c6t0d27
c7t0d27
c2t0d47
c3t0d47
c6t0d47
c7t0d47
```

```
c2t0d67
c3t0d67
c6t0d67
c7t0d67
c2t0d87
c3t0d87
c6t0d87
c7t0d87
c2t0d107
c3t0d107
c6t0d107
c7t0d107
c2t0d127
c3t0d127
c6t0d127
c7t0d127
c2t0d147
c3t0d147
c6t0d147
c7t0d147
END
VOLUME_GROUP: asu1-5 (d4)
STRIPE 8m
VOLUME 1
c2t0d8
c3t0d8
c6t0d8
c7t0d8
c2t0d28
c3t0d28
c6t0d28
c7t0d28
c2t0d48
c3t0d48
c6t0d48
c7t0d48
c2t0d68
c3t0d68
c6t0d68
c7t0d68
c2t0d88
c3t0d88
c6t0d88
c7t0d88
c2t0d108
c3t0d108
c6t0d108
c7t0d108
c2t0d128
c3t0d128
c6t0d128
c7t0d128
c2t0d148
c3t0d148
c6t0d148
c7t0d148
END
VOLUME_GROUP: asu1-6 (d5)
STRIPE 8m
VOLUME 1
c2t0d11
c3t0d11
c6t0d11
```

```
  c7t0d11
  c2t0d31
  c3t0d31
  c6t0d31
  c7t0d31
  c2t0d51
  c3t0d51
  c6t0d51
  c7t0d51
  c2t0d71
  c3t0d71
  c6t0d71
  c7t0d71
  c2t0d91
  c3t0d91
  c6t0d91
  c7t0d91
  c2t0d111
  c3t0d111
  c6t0d111
  c7t0d111
  c2t0d131
  c3t0d131
  c6t0d131
  c7t0d131
  c2t0d151
  c3t0d151
  c6t0d151
  c7t0d151
  END
  VOLUME_GROUP: asu1-7 (d6)
  STRIPE 8m
  VOLUME 1
  c2t0d12
  c3t0d12
  c6t0d12
  c7t0d12
  c2t0d32
  c3t0d32
  c6t0d32
  c7t0d32
  c2t0d52
  c3t0d52
  c6t0d52
  c7t0d52
  c2t0d72
  c3t0d72
  c6t0d72
  c7t0d72
  c2t0d92
  c3t0d92
  c6t0d92
  c7t0d92
  c2t0d112
  c3t0d112
  c6t0d112
  c7t0d112
  c2t0d132
  c3t0d132
  c6t0d132
  c7t0d132
  c2t0d152
  c3t0d152
```

```
c6t0d152
c7t0d152
END
VOLUME_GROUP: asu1-8 (d7)
STRIPE 8m
VOLUME 1
c2t0d13
c3t0d13
c6t0d13
c7t0d13
c2t0d33
c3t0d33
c6t0d33
c7t0d33
c2t0d53
c3t0d53
c6t0d53
c7t0d53
c2t0d73
c3t0d73
c6t0d73
c7t0d73
c2t0d93
c3t0d93
c6t0d93
c7t0d93
c2t0d113
c3t0d113
c6t0d113
c7t0d113
c2t0d133
c3t0d133
c6t0d133
c7t0d133
c2t0d153
c3t0d153
c6t0d153
c7t0d153
END
VOLUME_GROUP: asu1-9 (d8)
STRIPE 8m
VOLUME 1
c2t0d14
c3t0d14
c6t0d14
c7t0d14
c2t0d34
c3t0d34
c6t0d34
c7t0d34
c2t0d54
c3t0d54
c6t0d54
c7t0d54
c2t0d74
c3t0d74
c6t0d74
c7t0d74
c2t0d94
c3t0d94
c6t0d94
c7t0d94
c2t0d114
```

```
c3t0d114
c6t0d114
c7t0d114
c2t0d134
c3t0d134
c6t0d134
c7t0d134
c2t0d154
c3t0d154
c6t0d154
c7t0d154
END
VOLUME_GROUP: asu2-1 (d9)
STRIPE 8m
VOLUME 1
c2t0d0
c3t0d0
c6t0d0
c7t0d0
c2t0d20
c3t0d20
c6t0d20
c7t0d20
c2t0d40
c3t0d40
c6t0d40
c7t0d40
c2t0d60
c3t0d60
c6t0d60
c7t0d60
c2t0d80
c3t0d80
c6t0d80
c7t0d80
c2t0d100
c3t0d100
c6t0d100
c7t0d100
c2t0d120
c3t0d120
c6t0d120
c7t0d120
c2t0d140
c3t0d140
c6t0d140
c7t0d140
END
VOLUME_GROUP: asu2-2 (d10)
STRIPE 8m
VOLUME 1
c2t0d1
c3t0d1
c6t0d1
c7t0d1
c2t0d21
c3t0d21
c6t0d21
c7t0d21
c2t0d41
c3t0d41
c6t0d41
c7t0d41
```

```
c2t0d61
c3t0d61
c6t0d61
c7t0d61
c2t0d81
c3t0d81
c6t0d81
c7t0d81
c2t0d101
c3t0d101
c6t0d101
c7t0d101
c2t0d121
c3t0d121
c6t0d121
c7t0d121
c2t0d141
c3t0d141
c6t0d141
c7t0d141
END
VOLUME_GROUP: asu2-3 (d11)
STRIPE 8m
VOLUME 1
c2t0d2
c3t0d2
c6t0d2
c7t0d2
c2t0d22
c3t0d22
c6t0d22
c7t0d22
c2t0d42
c3t0d42
c6t0d42
c7t0d42
c2t0d62
c3t0d62
c6t0d62
c7t0d62
c2t0d82
c3t0d82
c6t0d82
c7t0d82
c2t0d102
c3t0d102
c6t0d102
c7t0d102
c2t0d122
c3t0d122
c6t0d122
c7t0d122
c2t0d142
c3t0d142
c6t0d142
c7t0d142
END
VOLUME_GROUP: asu2-4 (d12)
STRIPE 8m
VOLUME 1
c2t0d3
c3t0d3
c6t0d3
```

```
c7t0d3
c2t0d23
c3t0d23
c6t0d23
c7t0d23
c2t0d43
c3t0d43
c6t0d43
c7t0d43
c2t0d63
c3t0d63
c6t0d63
c7t0d63
c2t0d83
c3t0d83
c6t0d83
c7t0d83
c2t0d103
c3t0d103
c6t0d103
c7t0d103
c2t0d123
c3t0d123
c6t0d123
c7t0d123
c2t0d143
c3t0d143
c6t0d143
c7t0d143
END
VOLUME_GROUP: asu2-5 (d13)
STRIPE 8m
VOLUME 1
c2t0d15
c3t0d15
c6t0d15
c7t0d15
c2t0d35
c3t0d35
c6t0d35
c7t0d35
c2t0d55
c3t0d55
c6t0d55
c7t0d55
c2t0d75
c3t0d75
c6t0d75
c7t0d75
c2t0d95
c3t0d95
c6t0d95
c7t0d95
c2t0d115
c3t0d115
c6t0d115
c7t0d115
c2t0d135
c3t0d135
c6t0d135
c7t0d135
c2t0d155
c3t0d155
```

```
c6t0d155
c7t0d155
END
VOLUME_GROUP: asu2-6 (d14)
STRIPE 8m
VOLUME 1
c2t0d16
c3t0d16
c6t0d16
c7t0d16
c2t0d36
c3t0d36
c6t0d36
c7t0d36
c2t0d56
c3t0d56
c6t0d56
c7t0d56
c2t0d76
c3t0d76
c6t0d76
c7t0d76
c2t0d96
c3t0d96
c6t0d96
c7t0d96
c2t0d116
c3t0d116
c6t0d116
c7t0d116
c2t0d136
c3t0d136
c6t0d136
c7t0d136
c2t0d156
c3t0d156
c6t0d156
c7t0d156
END
VOLUME_GROUP: asu2-7 (d15)
STRIPE 8m
VOLUME 1
c2t0d17
c3t0d17
c6t0d17
c7t0d17
c2t0d37
c3t0d37
c6t0d37
c7t0d37
c2t0d57
c3t0d57
c6t0d57
c7t0d57
c2t0d77
c3t0d77
c6t0d77
c7t0d77
c2t0d97
c3t0d97
c6t0d97
c7t0d97
c2t0d117
```

```
c3t0d117
c6t0d117
c7t0d117
c2t0d137
c3t0d137
c6t0d137
c7t0d137
c2t0d157
c3t0d157
c6t0d157
c7t0d157
END
VOLUME_GROUP: asu2-8 (d16)
STRIPE 8m
VOLUME 1
c2t0d18
c3t0d18
c6t0d18
c7t0d18
c2t0d38
c3t0d38
c6t0d38
c7t0d38
c2t0d58
c3t0d58
c6t0d58
c7t0d58
c2t0d78
c3t0d78
c6t0d78
c7t0d78
c2t0d98
c3t0d98
c6t0d98
c7t0d98
c2t0d118
c3t0d118
c6t0d118
c7t0d118
c2t0d138
c3t0d138
c6t0d138
c7t0d138
c2t0d158
c3t0d158
c6t0d158
c7t0d158
END
VOLUME_GROUP: asu2-9 (d17)
STRIPE 8m
VOLUME 1
c2t0d19
c3t0d19
c6t0d19
c7t0d19
c2t0d39
c3t0d39
c6t0d39
c7t0d39
c2t0d59
c3t0d59
c6t0d59
c7t0d59
```

```
c2t0d79
c3t0d79
c6t0d79
c7t0d79
c2t0d99
c3t0d99
c6t0d99
c7t0d99
c2t0d119
c3t0d119
c6t0d119
c7t0d119
c2t0d139
c3t0d139
c6t0d139
c7t0d139
c2t0d159
c3t0d159
c6t0d159
c7t0d159
END
VOLUME_GROUP: asu3-1 (d18)
STRIPE 8m
VOLUME 1
c2t0d9
c3t0d9
c6t0d9
c7t0d9
c2t0d29
c3t0d29
c6t0d29
c7t0d29
c2t0d49
c3t0d49
c6t0d49
c7t0d49
c2t0d69
c3t0d69
c6t0d69
c7t0d69
c2t0d89
c3t0d89
c6t0d89
c7t0d89
c2t0d109
c3t0d109
c6t0d109
c7t0d109
c2t0d129
c3t0d129
c6t0d129
c7t0d129
c2t0d149
c3t0d149
c6t0d149
c7t0d149
END
VOLUME_GROUP: asu3-2 (d19)
STRIPE 8m
VOLUME 1
c2t0d10
c3t0d10
c6t0d10
```

```
  c7t0d10
  c2t0d30
  c3t0d30
  c6t0d30
  c7t0d30
  c2t0d50
  c3t0d50
  c6t0d50
  c7t0d50
  c2t0d70
  c3t0d70
  c6t0d70
  c7t0d70
  c2t0d90
  c3t0d90
  c6t0d90
  c7t0d90
  c2t0d110
  c3t0d110
  c6t0d110
  c7t0d110
  c2t0d130
  c3t0d130
  c6t0d130
  c7t0d130
  c2t0d150
  c3t0d150
  c6t0d150
  c7t0d150
  END
```

APPENDIX D: SPC-1 WORKLOAD GENERATOR STORAGE COMMANDS AND PARAMETERS

The content of SPC-1 Workload Generator command and parameter file, used in this benchmark to execute the Primary Metrics and Repeatability Tests, is listed below.

```
javaparms="-Xmx1024m -Xms1024m -Xss512k"
sd=asu1_1,lun=/dev/md/rdsk/d0,size=267.770g
sd=asu1_2,lun=/dev/md/rdsk/d1,size=267.770g
sd=asu1_3,lun=/dev/md/rdsk/d2,size=267.770g
sd=asu1_4,lun=/dev/md/rdsk/d3,size=267.770g
sd=asu1_5,lun=/dev/md/rdsk/d4,size=267.770g
sd=asu1_6,lun=/dev/md/rdsk/d5,size=267.770g
sd=asu1_7,lun=/dev/md/rdsk/d6,size=267.770g
sd=asu1_8,lun=/dev/md/rdsk/d7,size=267.770g
sd=asu1_9,lun=/dev/md/rdsk/d8,size=267.770g
sd=asu2_1,lun=/dev/md/rdsk/d9,size=267.770g
sd=asu2_2,lun=/dev/md/rdsk/d10,size=267.770g
sd=asu2_3,lun=/dev/md/rdsk/d11,size=267.770g
sd=asu2_4,lun=/dev/md/rdsk/d12,size=267.770g
sd=asu2_5,lun=/dev/md/rdsk/d13,size=267.770g
sd=asu2_6,lun=/dev/md/rdsk/d14,size=267.770g
sd=asu2_7,lun=/dev/md/rdsk/d15,size=267.770g
sd=asu2_8,lun=/dev/md/rdsk/d16,size=267.770g
sd=asu2_9,lun=/dev/md/rdsk/d17,size=267.770g
sd=asu3_1,lun=/dev/md/rdsk/d18,size=267.770g
sd=asu3_2,lun=/dev/md/rdsk/d19,size=267.770g
```

APPENDIX E: SPC-1 WORKLOAD GENERATOR INPUT PARAMETERS

Primary Metrics Test, Repeatability Test, and Persistence Test

The following script was used to execute the Primary Metrics Test *(Sustainability Test Phase, IOPS Test Phase, and Response Time Ramp Test Phase)*, Repeatability Test *(Repeatability Test Phase 1 and Repeatability Test Phase 2)*, and Persistence Test. The Primary Metrics Test, Repeatability Test, and Persistence Test Run 1 were executed in an uninterrupted sequence. The script specified a ten (10) minute pause between Persistence Test Run 1 and Persistence Test Run 2 during which the required Tested Storage Configuration power cycle was successfully completed. That action was documented by TSC activity log entries.

```
#DX80_fdr.sh

sleep 14400

#metrics
echo "metrics start at `date`" | tee -a
/SPC1_work_DX80_0811_FDR_bsu390/metrics_running.txt
java -Xmx1024m -Xms1024m -Xss512k metrics -b 390
echo "metrics running end at `date`" | tee -a
/SPC1_work_DX80_0811_FDR_bsu390/metrics_running.txt

#repeat-1
echo "repeat1 running start at `date`" | tee -a
/SPC1_work_DX80_0811_FDR_bsu390/repeat1_running.txt
java -Xmx1024m -Xms1024m -Xss512k repeat1 -b 390
echo "repeat1 running end at `date`" | tee -a
/SPC1_work_DX80_0811_FDR_bsu390/repeat1_running.txt

#repeat-2
echo "repeat2 start at `date`" | tee -a
/SPC1_work_DX80_0811_FDR_bsu390/repeat2_running.txt
java -Xmx1024m -Xms1024m -Xss512k repeat2 -b 390
echo "repeat2 running end at `date`" | tee -a
/SPC1_work_DX80_0811_FDR_bsu390/repeat2_running.txt

#persist-1
echo "persist1 running start at `date`" | tee -a
/SPC1_work_DX80_0811_FDR_bsu390/persist1_running.txt
java -Xmx1024m -Xms1024m -Xss512k persist1 -b 390
echo "persist1 running end at `date`" | tee -a
/SPC1_work_DX80_0811_FDR_bsu390/persist1_running.txt

sleep 600

#persist-2
echo "persist2 running start at `date`" | tee -a
/SPC1_work_DX80_0811_FDR_bsu390/persist2_running.txt
java -Xmx1024m -Xms1024m -Xss512k persist2
echo "persist2 running end at `date`" | tee -a
/SPC1_work_DX80_0811_FDR_bsu390/persist2_running.txt

mv metrics metrics_DX80_0811_FDR_bsu390
mv repeatability1 repeat1_DX80_0811_FDR_bsu390
mv repeatability2 repeat2_DX80_0811_FDR_bsu390
mv persistence1 persist1_DX80_0811_FDR_bsu390
mv persistence2 persist2_DX80_0811_FDR_bsu390
```

```
mv SPCOut SPCOut_DX80_0811_FDR_bsu390

zip -r metrics_DX80_0811_FDR_bsu390.zip metrics_DX80_0811_FDR_bsu390
zip -r repeat1_DX80_0811_FDR_bsu390.zip repeat1_DX80_0811_FDR_bsu390
zip -r repeat2_DX80_0811_FDR_bsu390.zip repeat2_DX80_0811_FDR_bsu390
zip -r persist1_DX80_0811_FDR_bsu390.zip persist1_DX80_0811_FDR_bsu390
zip -r persist2_DX80_0811_FDR_bsu390.zip persist2_DX80_0811_FDR_bsu390
zip -r SPCOut_DX80_0811_FDR_bsu390.zip SPCOut_DX80_0811_FDR_bsu390
```